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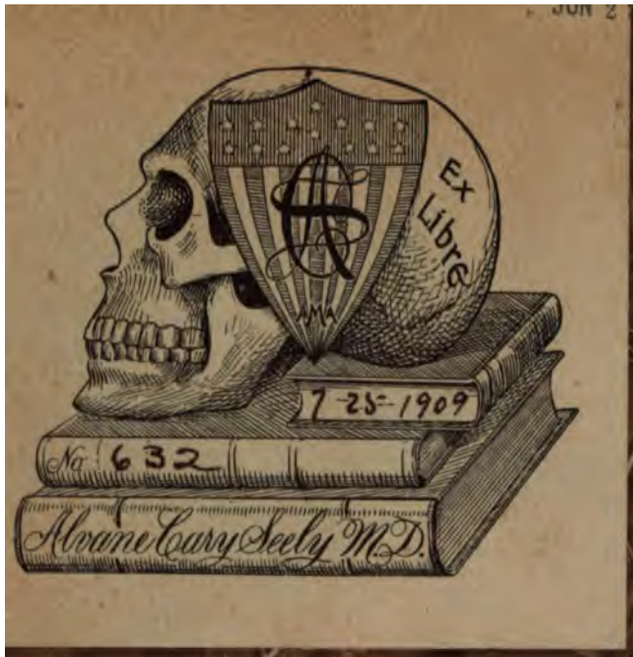


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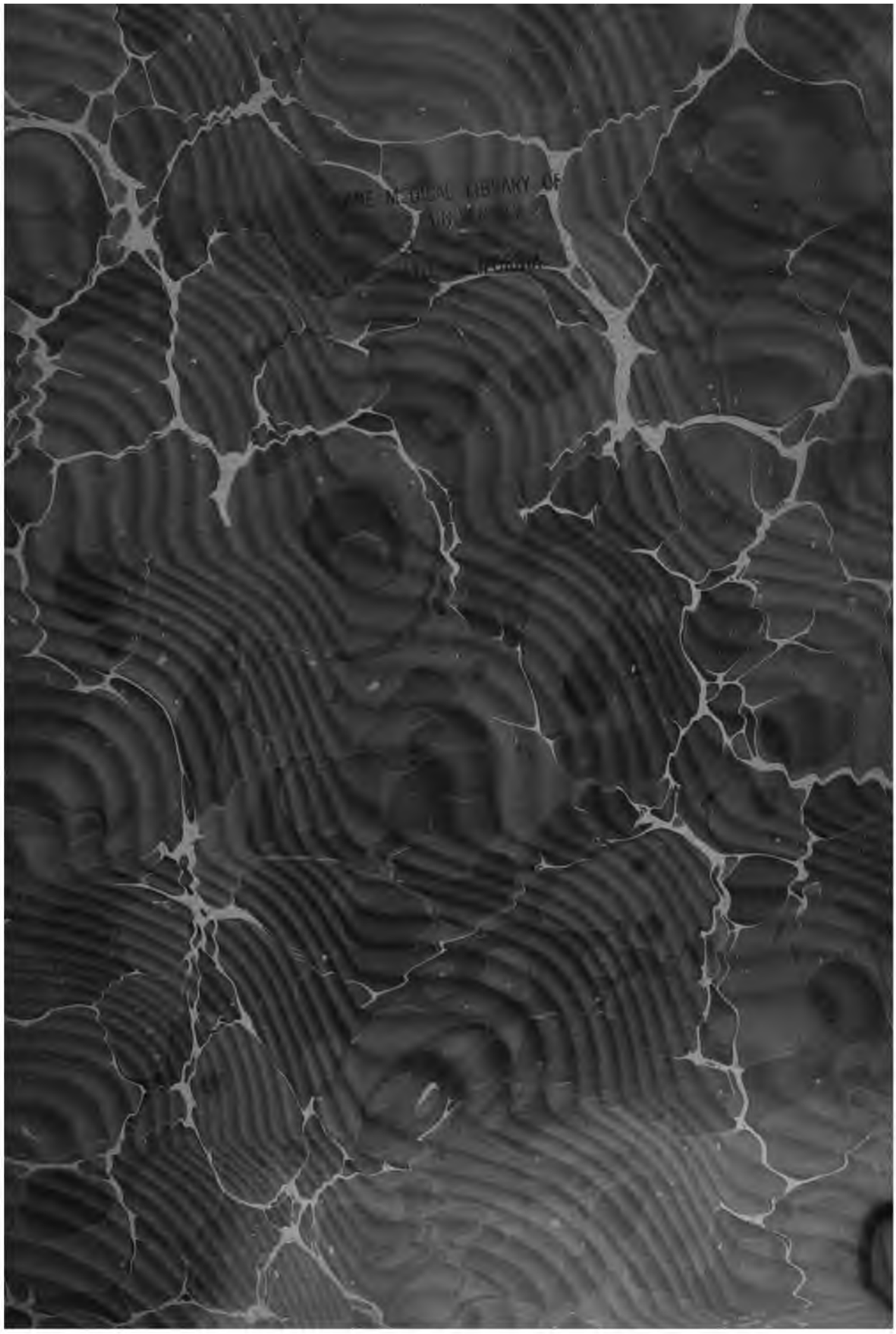

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# THE DEVELOPMENT AND TECHNIQUE OF THE MODERN MASTOID OPERATION

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THE

# MODERN MASTOID OPERATION

BY

FREDERICK WHITING, A.M., M.D.

PROFESSOR OF OTOLOGY, CORNELL UNIVERSITY MEDICAL COLLEGE; AURAL SURGEON TO NEW YORK EYE AND EAR INFIRMARY; SURGEON TO ST. BARTHOLOMEW'S CLINIC, ETC.

ILLUSTRATED BY TWENTY-FIVE HALF-TONE AND TWENTY-THREE KEY PLATES MADE FROM ORIGINAL DRAWINGS.

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TO

DR. GORHAM BACON

this volume is dedicated in grateful remembrance of valuable instruction and in sincere admiration of a scholarly contributor to otology.

# PREFACE.

The preparation of this little book, which the writer now offers to the medical public, has been undertaken at the earnest solicitation of numerous practitioners who have from time to time attended upon his clinics, and who have expressed themselves as unable to acquire the technique requisite for the performance of the mastoid operation, under stress of emergency, from any of the standard works upon otology or from such experience as can be gained by witnessing at the hands of skilful surgeons the relatively small number of operations which are open to public inspection during the necessarily infrequent and brief visits to the metropolis which the exigencies of busy practice permit.

Largely in the interest of the class mentioned the appended detailed technique, with the accompanying graphic illustrations, has been attempted, and with a view also to lightening the perplexities of the bewildered beginner who is making a serious study of otology with the ultimate purpose of exclusive practice in that branch.

The possibilities of the surgery of the mastoid process AS REGARDS THE EXTENT OF PROCEDURES upon that structure for the relief of inflammatory conditions are practically exhausted; there remains then only the necessity for perfecting our technique in order that the needful steps may be accomplished with neatness and with the requisite despatch.

After considerable operative experience the author has endeavored so to systematize the steps of the procedure for the relief of suppurative mastoiditis as to realize certain beneficial results, namely, the complete eradication of all diseased tissue in the shortest time commensurate with thoroughness, while pursuing a method designed to reduce to a minimum the dangers incident to the operation and calculated as well to induce speedy and permanent healing.

It seems an entirely warrantable conclusion that the experience in operating which the clinics of large metropolitan institutions afford will in time be productive of extraordinary technical skill upon the part of surgeons who enjoy the advantages of such service. The special hospitals more even than the others favor the development of technical proficiency to a high degree, and certainly as regards procedures upon the mastoid otologists may claim without undue egotism to have made flattering progress in that direction. The day is already long past when an operator who professes to be an ear surgeon can exploit his pretensions to such consideration upon an ability to locate the antrum *in most instances or under favorable circumstances*, although the possession of such a qualification would have been regarded but a decade since as an adequate demonstration of special skill in otology.

Those readers who scrutinize this book with the expectation of finding the technique of the radical operation for chronic otorrhœa described, or the methods of procedure in sinus throm-

bosis, brain abscess, or other intracranial inflammatory process included in its scope, will be disappointed, for the writer has reserved a similar treatment of these complications of mastoid disease for the not distant future, when they will be presented under the title "Otitic Surgery of the Temporo-Mastoid Region."

The great interest in and importance of the modern mastoid operation appears to furnish adequate reason for the elaboration of the subject by monograph, since, owing to lack of space, the most voluminous of recent text-books does not attempt the minutiæ of detail which are indispensable to the beginner in his lack of experience; such special departments of a specialty are, in fact, beyond the capacity of any work not encyclopedic in its character.

The writer desires to make full and cordial acknowledgment of the investigations of Prof. Wilhelm Meyer, to whose classical studies he is largely indebted for the valuable historical data which appear in the first part of the book.

47 West 50th St., New York
January 1905.

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# HISTORICAL PORTION.

# CHAPTER I.

# THE DEVELOPMENT OF THE OPERATION FOR DRILLING THE MASTOID PROCESS.

# THE DEVELOPMENT OF THE OPERATION FOR DRILLING THE MASTOID PROCESS.

As a life-saving measure few surgical procedures rival and none surpass in efficiency the modern mastoid operation, the meritorious achievements of which very properly entitle it to the approbation and esteem of the medical profession and to the enduring gratitude and applause of an appreciative public.

Brilliant as are the triumphs of surgery, no brighter page ornaments its records than that which chronicles the recent remarkable progress in the diagnosis and treatment of mastoid and intracranial infective diseases in the development of which the otologist, we are proud to say, has borne a by no means inconspicuous part.

A brief consideration of the elements of chronological importance in the development of the mastoid operation is replete with interest and affords an excellent illustration of the trivial and unpromising beginnings from which momentous results may issue, for however insignificant may be the source, or however tran-

sitory the inspiration from which springs any enterprise the subsequent development of which is productive of great benefit to mankind, an historical sketch of the origin, growth, and successful prosecution of such effort must inevitably possess a fascination alike for the craftsman who profits by its practice as well as for the beneficiary who avails himself of the perfected method.

The prevalence of mastoid disease and the severity of the complications for which its extension is responsible have at length enforced at the hands of surgeons and otologists a degree of consideration which may be regarded as fairly commensurate with the gravity of the situation.

It is but a few years since the classical or Schwartze operation was resorted to only under the stress of imperative necessity as a kind of last resort against a fatal termination; while the radical procedure for the cure of chronic suppuration had not as yet even been proposed. Both of these measures are today of such frequent occurrence as to be no longer noteworthy, and constitute a medium of incalculable benefit to suffering humanity.

Acute purulent mastoiditis as well as the chronic processes to which this region is prone occurs, it is needless to emphasize, with greatest frequency among the laboring and less intelligent classes, chiefly owing to the nature of their calling and because of neglect; these persons are, in the pursuit of their vocation, continually exposed to the inclemency of the weather, the lighter ills engendered by which they commonly disregard as undeserving of attention. They have also the habit when ailing of employing "home remedies" so called, until the exigencies of the condition are such as, by reason either of intolerable pain or excessive weakness, to demolish their stoical indifference and compel them to seek professional medical assistance.

Neglect, abetted by the misdirected zeal of sympathizing rela-

tives and friends whose ministrations range from harmless advice to most dangerous and pernicious practice, must be recognized as a potent agency in the production of the ills of the very poor and ignorant. The task of so far enlightening this stratum of humanity as to enable its individuals to appreciate that their welfare alone is the aim of the doctor in proposing operation, and not merely the gratification of an idle propensity upon his part for experimental surgery, has been an arduous and a slow one, for the initiative in which, as in so many other beneficent endeavors, we are under obligation to our German medical confrères, for to the originality of procedure, fertility of resource, and conscientious study of Schwartze and Staacke we are indebted for the resistless impetus which has contributed to the development of this most serviceable and at the present day indispensable operation.

The justice of this commendation will be recognized and the claim substantiated upon critical analysis of the numerous variations and modifications which have from time to time, since the earlier publications of Schwartze and Staacke, been heralded as possessing radical departures of method. Such procedures are all more or less identical with the original propositions of these two masters; as, for example, when in acute purulent inflammations they advocate the removal of a little more or a little less of the mastoid process, they are but endorsing Schwartze still; while in chronic suppurative conditions, be the flaps of whatever shape or size, applied above or below, constructed from the fibro-cartilaginous meatus of the auricle or transplanted from some remote cutaneous surface, the measure is simply an elaboration of Staacke and not in opposition to him. To these two pioneers then are we under lasting obligation for our conception of the technical basis of the modern mastoid operation, and in some measure also for the favorable attitude which the public,

A retrospect, then, of the conditions and occasions out of which grew our present felicitous state may prove a matter of historical interest even should the recital disclose but little information of scientific value to the reader.

With our present accurate knowledge of the pathology of the diseases with which we are dealing we are prone to ridicule the procedures of antiquity, founded as they were for the most part upon a complete misconception of the fundamental principles governing the production of the condition for the amelioration of which they strove, and we are addicted, with a spirit scarcely chivalrous indeed, to minifying even those attainments in which our remote predecessors might justly have taken pride.

A careful scrutiny of the earliest recorded practice of physic, from the time of Hippocrates, 460 to 377 B. C., to the later teachings of that arrant egotist Ambroise Parè, 1510 to 1590 A. D., while it will provoke many a smile of amusement or perhaps of derision at the numerous fantastic remedies to which specific virtues were attributed, will reveal as well a quality of sound judgment and good sense which commends itself to our most respectful consideration.

That the practice of any special branch of medicine should have received at the hands of these early devotees any consideration other than the most superficial was, of course, not to be anticipated; nevertheless, we find a gratifying disposition upon the part of Hippocrates and many of his less illustrious followers to recognize the distinctive nature of ailments of the special organs in the treatment of which they advocated the use of "water and other mild remedies," lest by the employment of more severe measures they should aggravate the distemper rather than benefit the sufferer. Such therapy might indeed be denominated purely *expectant treatment*, but it possessed at least one virtue which has been conspicuously wanting among many of the curative

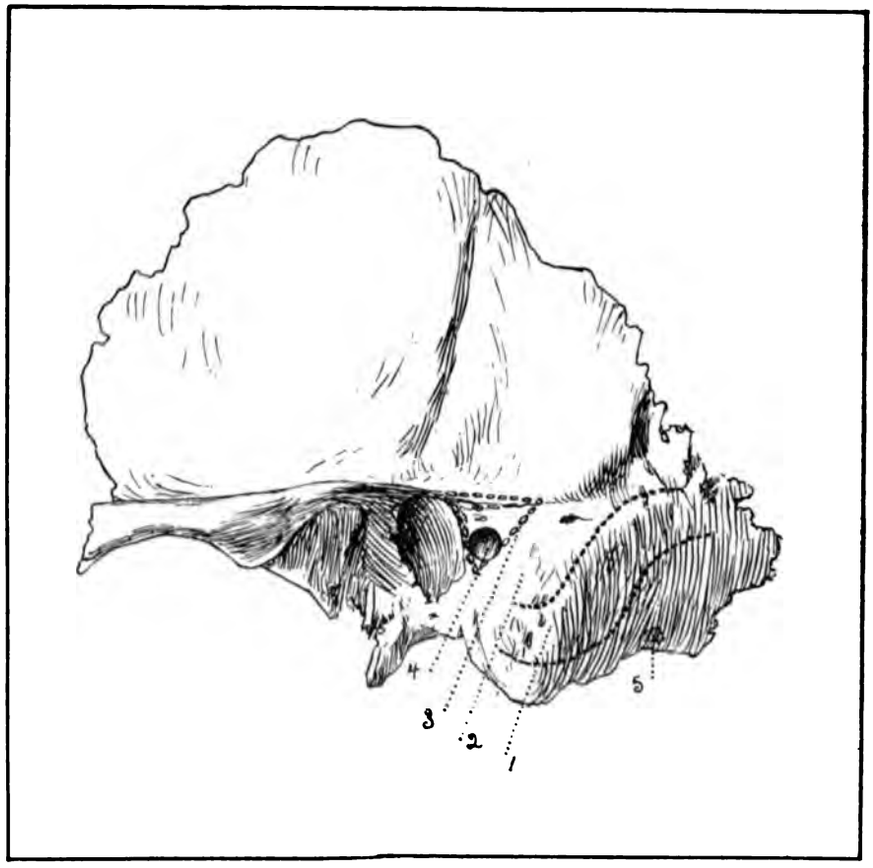
agents so highly commended in the last century and so justly condemned in the present, *it did not inflict gratuitous injection upon an organ already harassed by a distressing malady.* That otology which has only within a generation enforced the reluctant recognition of its claims to the dignity of a science should find in the precepts of antiquity any guiding motive which could with profit be turned to modern surgical account appears rather improbable, but it is none the less true that certain of our recognized practices to-day differ in detail only from the established methods of the fifth century before Christ.

For example, Hippocrates advised in *acute inflammation* of the middle ear the employment of depletion by local blood-letting and the instillation of warm mild drops into the ear which was to be steamed; in addition to which he prescribed a cathartic and enjoined upon the patient absolute rest.

In the treatment of *chronic suppuration* of the ear his therapy was equally admirable and comprised the use of warm irrigation followed by the administration of some astringent solution either vegetable or mineral, for he was familiar with the properties of each and recommended as especially suitable to such conditions an acetate of iron (Oeuvres complètes d' Hippokrate; traduction nouvelle par E. Litré, Vol. V–VII, Paris, 1839, 1866; Greek and French).

The above recounted methods of procedure differ in no material respect from our present practices, nor need these measures be regarded as solitary examples of practical value which have survived from a heterogeneous array of worthless maxims and obsolete mechanical devices, for the same authority says regarding aural polypi that they should be carefully plucked from the canal of the ear and the organ thoroughly cleansed with water and subsequently treated by the instillation of an astringent lotion, and he affirms that hearing is improved and mal-

## EXPLANATORY NOTE TO PLATE A.




This plate shows:

A left temporal bone, the mastoid process of which is broad and flat, with the sigmoid sinus (in dotted outline) (1) situated, as would be expected in a bone of such shape, far back from the meatus and well removed from the risks of operation. (2) A very gradual slope of the cortex toward the brim of the meatus, with the posterior wall of which it unites at a very slight angle; a feature significant of the probability that the sinus is deeply situated. (3) Dotted lines indicating the position of the suprameatal triangle in its relation with the meatus and the temporal ridge. (4) The point of election for trephining or perforating with the drill in the old and long since abandoned operation at the inferior angle of the suprameatal triangle; the opening represented is about the size made by the drill which was formerly employed and regarded as adequate. (5) The mastoid foramen.

PLATE A.

odorous discharge diminished thereby. The employment of the speculum with adequate illumination has, of course, immeasurably improved upon the Hippocratic technique, and antisepsis has likewise contributed to a more efficient and scientific therapy, but the fundamental principles embodied in that early teaching, namely, *removal of the growth and post-operative cleanliness with subsequent astringent applications*, contain the substance of modern practice.

The conversation tube still further illustrates the unsubstantial nature of all claims to originality in the production of any contrivance, for there exists indisputable evidence that such an appliance as a medium for the collection and transmission of sonorous vibrations was well known and highly appreciated at least fifteen hundred or more years ago (Archigenes, Trallianus), and that the device of the present day is employed much as it was then used, only with such modifications of shape and size as the exigencies and elegances of modern social requirements impose.

To determine with accuracy the precise date at which any surgical procedure was first performed or to decide with certainty upon the claims which entitle one operator rather than another to the distinction of priority in such performance, save in instances where the operation is of quite recent production and calculated to fulfil some contingency created by modern conditions of life, is usually a difficult and sometimes an impossible task, and equally unreliable will often prove all obtainable information concerning the indications which prompted the original manœuvre.

As regards the surgery of the mastoid region there is a manifest disinclination among early medical writers to attribute the entire credit of having first suggested the possibility of trephining the process to any one surgeon, and in consideration of the incalculable benefits conferred by the modern operation upon

would permit the ear to resume the exercise of its suspended function of audition.

These theorizers proposed to so trephine the mastoid process that a cortical opening should communicate with the antrum and thence with the tympanum, thereby admitting air to the middle ear and equalizing the atmospheric pressure upon each side of the membrana tympani, and they expressed a belief that the approach thus established could be maintained in the form of a permanent fistulous tract.

Although suggesting the procedure with a degree of apparent confidence in its wisdom and utility, neither writer appears to have possessed the requisite fortitude to put his courage to the touch, for there exists no record confirmatory of the belief that either Rolfinck or Riolan ever attempted to perform the operation, nevertheless their ardent advocacy of the measure resulted in the subsequent confusion and undoing of some of their more enthusiastic but less circumspect followers.

So far as known the earliest observer *to utilize spontaneous opening of the mastoid process* as an agency for the relief of otorrhœa was Valsalva (Viri celeberrimi Antonii Mariæ Valsalvæ opera. Hoc est tractatus de aure humana, etc., Venice, Chap. V, 1720) in 1740, and later Heuermann (Heuermann, Abh. v. d. Vornehmsten chirurgischen Operationen, Kopenhagen, 1757, Vol. III, p. 192) in 1757, each of whom reported a case of spontaneous perforation of the mastoid cortex and integument as the result of necrosis in the course of a suppurative otitis media, in which individuals they severally practiced syringing through the opening behind the ear into the tympanum; but neither practitioner appears to have been impressed with the importance of the step or to have possessed an adequate conception of its possible value as a surgical measure for the relief of chronic suppuration of the ear, in which respect these two students were con-

spicuously at variance with Rolfinck and Riolan, who were disposed in an excess of zeal to attach entirely unwarranted significance to a proposition which had not progressed beyond pure hypothesis and of which the experimental stage was yet to begin.

While Valsalva and Heuermann were the first surgeons of record to take advantage of the opening in the mastoid for purposes of irrigation, *they did not produce the opening but simply availed themselves of nature's kindly offices* to accelerate what would otherwise have been an equally favorable although more protracted convalescence. Neither Rolfinck nor Riolan could justly support his pretension to priority in the matter of artificially opening the mastoid process for any purpose whatever, for while they did indeed place themselves upon record as advocating such a procedure, it does not appear that either attempted its performance in vindication of his fantastic and erroneous notions. The unqualified credit for priority in the artificial opening of the mastoid process is justly attributed to the celebrated French surgeon Jean Louis Petit, 1674–1760 (Jean Louis Petit, Traité des maladies chirurgicales et des operations qui leur conviennent, Paris, 1774, tome 1, pages 139 to 174). He it was who first appreciated the value of the step as a life-saving measure and to his unerring judgment and keen intelligence must be awarded the honor of instituting even in that unenlightened age a rational therapy which would have compelled a much earlier and more universal recognition of the inestimable value of the operation had his followers been content to adhere to the indications which he formulated instead of being led, by wilful misinterpretation of the aims and objects of the operation, into performances which discredited the operator and aroused an undeserved hostility against the procedure, as the direct result of which agitation the development of one of surgery's greatest achievements was arrested for a full century and the progress of science

for a similar period was stayed in its onward march. On several occasions before 1761 Petit operated successfully in cases of suppurative mastoiditis of sufficient gravity to threaten loss of life, and he thereupon affirmed in the medical literature of the time his belief that purulent inflammation of the mastoid, with caries, was the only indication for trephining the process, and in his work upon surgery (*l. c.*) he emphasizes still further the symptomatology and furnishes illustrations of the instruments which he had employed, in one instance a chisel and on other occasions a pointed perforatorium or drill.

No shadow of suspicion can justly be entertained regarding the trustworthiness of the evidence which supports the claims of Petit to priority in the performance of the operation for suppurative osteo-myelitis of the mastoid process, and that the influence of his inspired utterances upon the subject should not have been more decided and enduring is a sad commentary upon the jealousy and skepticism of his times. His experience indeed adds but another instance to the many in history of a talented mentor whose precept and practice although alike brilliant and successful failed to carry conviction to his associates; the fault, however, lay with them, not with him—they were unworthy disciples!

Sixteen years later (1776) a Prussian regimental surgeon, Jasser by name, although entirely unacquainted with the work and writings of Petit, successfully operated upon the right mastoid of a soldier who had long been deaf and who had suffered from repeated attacks of suppurative otitis media. During one of these attacks the left mastoid process had become inflamed and spontaneous perforation of the cortex and integument had ensued with subsequent speedy and satisfactory healing upon the employment of irrigation through the opening. When, therefore, at a later period the right mastoid of the same patient plainly exhibited

## EXPLANATORY NOTE TO PLATE B.

This plate shows:

A left temporal bone, the mastoid process of which, while not especially narrowed, is very convex and round; an indication that the sigmoid sinus may be expected to lie superficially, that is to say, close beneath the cortex; caution should be exercised in opening such a process, lest the sinus be wounded by the chisel.

(1) A wide meatus, which enters the bone almost vertically to the mastoid surface; a structural peculiarity indicative of the presence of the sinus far forward, *i. e.*, close to the posterior wall of the bony meatus.

(2) A large cortical opening made for the purpose of demonstrating the Schwartze procedure; this opening, as must always be in narrowed mastoid processes, is funnel-shaped, with the apex of the funnel corresponding to the antrum.

(3) The mastoid tip and the zygomatic root cells undisturbed by the Schwartze operation.

(4) The mastoid foramen, from which a bristle protrudes, which in this bone is situated at an unusual distance from the tip.

PLATE B.

signs of a severe purulent inflammation this astute diagnostician uncovered the mastoid cortex by incision through the soft tissues and with a trocar perforated the outer table, entering a pus cavity, by means of which opening communication with the antrum and thence with the middle ear was established; attempts at through syringing were successful and the patient recovered with complete healing in the brief period of three weeks, and inasmuch as by good fortune the chronic suppuration was cured by the treatment and his hearing noticeably improved, the procedure was thereupon heralded by the profession as a radical cure for deafness of every kind, quite irrespective of its character and entirely independent of the symptoms manifested. Jasser himself appears to have been convinced of the value of the operation as a remedial agency in deafness (J. L. Schmucker's vermischte chirurgischse Schriften, Berlin, 1782, Bd. III, page 122), for he recommends it as a measure likely to prove efficient for the relief of "*deafness in general*"—a term sufficiently comprehensive and vague.

The so-called "Jasser operation" was speedily recognized and widely discussed, but either the profession was skeptical of its boasted merits or the laity were reluctant to avail themselves of its specious promises, for at least ten years elapsed before any surgeon appeared with the hardihood to undertake the task; at the expiration of which period (1785 to 1790) an operator, Fielitz by name, entered the field of otology (Richter's chirurgische Bibliothek, Bd. VIII, page 324; also Bd. IX, page 555); he was possessed of the requisite fortitude to insure not only the performance of the operation, but to judge by his subsequent report endowed as well with the needful assurance to warrant the unequivocal success of any step which he might attempt, providing the publishing of the same were entrusted to him. According to his account he operated upon three persons, all of whom were very

deaf, perforating both mastoids in two of the individuals and one mastoid in the third (in only one of the patients thus experimented upon was there otorrhœa); all the cases exhibited speedy and uneventful convalescence without complications and *with complete restoration of hearing.*

"Results so astounding," says Professor Meyer, in commenting upon Fielitz's contribution, "must of necessity be accepted with very decided reservation," since in the light of our present knowledge this glib report is simply incredible.

At the next performance of the operation, undertaken by the Prussian surgeon A. F. Loefler (1785–1790) (Richter's chirurgische Bibliothek, Bd. X, page 876) for the relief of deafness which had supervened upon very severe fever, the attempt at through syringing was not successful, and whatever improvement in hearing ensued as a result of the procedure was entirely lost upon the healing of the wound. Loefler's conclusion was therefore that success could attend upon the operation as a means of restoring loss of hearing only when a permanent fistulous opening communicating with the tympanum could be maintained.

The experience of Hagstrom, a Swedish physician, who shortly after Loefler's conspicuous failure undertook the operation, was even less favorable (Neue Abhdlgn. der Königl. Schwedischen Acad. der Wissensch., 1789, Bd. X, pages 184–194); not only did every attempt at syringing through the tympanum fail, but each trial was attended by a serious array of symptoms—pain in the head, tumultuous throbbing and roaring in the ears, embarrassed respiration, and finally loss of sight and syncope, whereupon further efforts were discontinued.

The enthusiasm for the new operation, which by reason of the experience of the last mentioned operators had been very decidedly dampened, received in 1791 a still more impressive rebuke, when at his own earnest solicitation the celebrated Danish

court physician, Johan Just von Berger, was operated upon in Copenhagen by Kolpin for the relief of deafness and distressing tinnitus.

The patient was attacked during the performance of the operation with vertigo and intense pain in the head, communication with the tympanum was not established as the result of the procedure, and on the succeeding days there appeared fever with pronounced fluctuations, which manifestations continued until the thirteenth day after the operation, when Berger died of purulent meningitis and sinus thrombosis.

Thus was added still another illustrious name to the appalling list of victims of misdirected professional zeal for new but inadequately tried surgical measures. (J. C. Tode, Arzneikundige Annalen, Heft 12, page 52, Kopenhagen, 1792; also Congrès internationale périodique des sciences médicales, 8 me Session, Copenhagen, 1884. Compte rendu des travaux de la section d'Otologie, page 56, "The Berger Case.") Notwithstanding the disastrous Berger incident, but a single year elapsed until in 1792, also in Copenhagen, a regimental surgeon, Proet by name, undertook the Jasser operation, for deafness, upon a soldier. (Tode, Arzneikundige Annalen, Heft 12, pages 63–72.) The syringing through was successful, but was accompanied by dizziness and fainting and followed shortly by high fever and purulent inflammation of the middle ear. The patient fortunately escaped with his life, although, as might be expected, he did not experience any improvement in hearing.

But one further operation of this character is recorded and that after the lapse of more than thirty years. It was performed by Webber in Hammelburg in the year 1824, and while unattended with serious consequences to the patient was equally unproductive of benefit; this date therefore, 1824, stands as an isolated monument to the credulity of the profession in the early years

of the last century: it defines also the chronological limit of those visionary and fantastic theories the application of which to disease conditions was productive only of aggravated symptoms and increased mortality. But, more important than all, for modern surgery it marks the beginning of a period in which every proposition was subjected to the searching scrutiny of impartial science and ratified or condemned in accordance as its claims were substantiated or disproved.

The greater the zeal in the beginning for the Jasser operation, just so much the more forcible was the revulsion against it which seized upon the medical world after its repeated and dismal failures: it was at length fully recognized that the indications for the procedure were indefinite, the prognosis doubtful, and the performance attended with danger to life: the operation was therefore abandoned by all and by most of the medical fraternity soon forgotten. Fifteen years had sufficed to demonstrate the hollowness of its pretensions, but fifty years barely served to reestablish in favor the discountenanced and repudiated measure when, rehabilitated and founded upon a rational pathology, it once again demanded recognition, this time bearing substantial promises, of the fulfilment of which we are to-day proud and willing witnesses.

With the repudiation of the Jasser operations all interest in mastoid surgery, for a protracted period, ceased, and such attention as was bestowed upon the region concerned the anatomy and physiology of the structure only, the knowledge of which had hitherto been of most elementary character and by no means such as could justify the indiscriminate exploratory boring to which it had been subjected.

The unfortunate results which had attended trephining of the mastoid process for the relief of deafness and subjective noises, while they exercised an influence which, so far as operating was

concerned, was at that time prohibitory, did not prove an unmitigated evil, since they were responsible as well, for an impetus to anatomical and physiological research which spurred the students of those branches onward with untiring energy and ever-increasing enthusiasm, until little by little with the progress of time a comprehensive understanding of the fundamental principles upon which all surgery and practice must rest, that a satisfactory outcome may be anticipated, was attained.

The names of many illustrious contributors are to be found among the literary efforts of this, for otology, momentous epoch, and while their work was not so startling or so brilliant as the surgical results which, founded upon it, were subsequently to excite the admiration and wonder of the medical world, it was none the less meritorious, and inasmuch as such efforts are awarded but scanty commendation and are under no circumstances productive of pecuniary compensation, an impulse so entirely devoid of mercenary motives is especially praiseworthy.

The early years of the nineteenth century, so far as clinical otology was concerned, dragged along in unproductive and fruitless succession; a discouraging indifference toward improved methods was manifested upon every side—neither protest nor appeal from those afflicted with inflammatory diseases of the ear served to arouse in the medical practitioners of the day a realizing sense of their flagrant deficiencies. Progress, instead of a watchword, was a term despised or forgotten and otological surgery, of which but a few years earlier such flattering prophecies had been made, became in truth little more than a byword and a reproach.

The advent of Jean Marc Gaspard Itard (1773 to 1858) upon the field furnished to otology the requisite inspiration for a revival of its languishing energies, and to the zealous efforts of this painstaking, accurate, and honest observer, prolonged, to the

## EXPLANATORY NOTE TO PLATE C.

This plate shows:

A left temporal bone, the broad and flat mastoid process of which has been entirely removed in order to demonstrate the extreme structural alterations possible when the complete mastoid operation has been practiced in some case of extensive mastoid suppuration. The mastoid tip as far as the occipital groove, also the cells at the root of the zygoma, have been removed. This plate furnishes a medium for comparison with the drill operation of Plate A and the Schwartze operation of Plate B. Bristle protruding from mastoid foramen.

PLATE C.

lasting benefit of science, over three-quarters of a century, must be attributed the influence which resulted in conferring upon the treatment of ear diseases the dignity of a specialty.

In reviewing the literature descriptive of the early development and growth of otology no student can fail to observe, and perhaps wonder at, the entirely insignificant and keenly disappointing character of contributions to this branch of medical science offered in the English language, for with the notable exception of Sims in 1787 and Saunders in 1808 none are worthy of mention.

The birthplace of otology was in France, its infancy was nurtured and its growth fostered in that country and in Germany and Holland, but the absence of all English influence is conspicuously and painfully apparent until the middle of the last century, when medical literature was enriched and medical science permanently endowed through the splendid efforts of two stalwart English minds who stamped with indelible imprint their individuality upon the archives of that period.

Few more illustrious names than those of William Robert Willis Wilde (1815 to 1876) and Joseph Toynbee (1815 to 1866) ornament the medical chronicles of any nation. Born in the same year, possessed of indefatigable energy, and endowed with intellectual powers of a high order, each enjoyed a distinguished career. Neither reached the age when the faculties begin to wane, and Toynbee indeed scarcely attained the plenitude of his powers. Their achievements, however, were so meritorious and reflected such enduring credit upon their chosen profession that their brethren find comfort in the reflection that while they might have enjoyed longer, they could scarcely have realized more creditable lives.

The work of one of these authors may be appropriately described as supplementary to that of the other. Toynbee was

essentially an analyst and pathologist; Wilde was a clinician of incomparable worth, and although each, as a medical contributor, was possessed of conspicuous merit and the one as fully entitled to the encomiums of posterity as the other, the name of Wilde has enjoyed a far greater familiarity with practitioners of the present day because of a procedure with which his reputation has been indissolubly linked and his fame perpetuated, namely, the much discussed "*Wilde's Incision.*"

Probably no surgical measure which had its foundation upon such frail anatomical and surgical supports ever enjoyed the distinction of a vogue so popular and prolonged as the "Wilde incision," and astonishing as the recital may seem it is none the less true that during the session of a recent Otological Congress this obsolete method of practice was still advocated as *an efficient remedy for suppurative mastoiditis* and evidence that its partisans were not merely an insignificant minority was afforded by a general and acrimonious discussion.

It almost transcends belief that any scientific assemblage of the present day should fritter away valuable time in debate either eulogistic of or disparaging to the Wilde incision, but the proceedings of the Congress recording the mortifying fact are accessible to all who care to peruse them.

At just what period in his career Wilde first began to practice the incision, the employment of which subsequently made him famous, can be determined with but relative exactness, nor does the author of the device in the English edition of his book (London, 1853), in which the procedure is fully described, consider the matter of chronology of sufficient moment to indicate the date of its first performance.

He advocated the incision as a satisfactory measure for the relief of *periostitis, incident to mastoiditis* which had progressed sufficiently to cause inflammation of the periosteum as indicated

by tenderness upon pressure and by redness and œdema of the integument of the mastoid region. The incision was to be made close to and parallel with the post-auricular fold and from three-fourths to one and a half inches in length, especial stress being laid upon the necessity of carrying the knife firmly down upon the bone. He asserts that tension upon the periosteum is thereby relieved and spontaneous perforation of the cortex favored in the near future if not immediately induced, but he nowhere suggests the advisability of trephining the mastoid in the event of failing to establish a cure by his vaunted method, deeming such a procedure a rash and hazardous expedient justifiable only when the patient is *in extremis*, and even then to be undertaken with great reluctance, since he regards the step *in the majority of instances as contributing simply to precipitate a fatal termination.*

In view of the hostile attitude toward mastoid surgery of so influential and liberal minded a man as Wilde there is little reason for wonder at the skeptical and antagonistic spirit with which every proposition looking toward more radical measures was received by the less intelligent and magnanimous fellows of the craft.

The step which Wilde, a pioneer, practiced in all sincerity, as the best his times afforded and because he knew of nothing better, a certain opinionated class of medical men desires to perpetuate long after its glory has departed and notwithstanding that its futility has been fully demonstrated. Their position is wholly indefensible, for, with our present knowledge of the pathology of mastoiditis, it is unpardonable neglect upon the part of any practitioner who fails to inform himself of the character of those structural changes in the osseous tissues which occur in the course of a purulent inflammation and which precede any periosteal manifestations.

*As a general proposition we may affirm that whenever Wilde's incision is indicated a mastoid operation is imperative.*

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The author feels it incumbent upon him to emphasize at perhaps wearisome length the inadequacy of the Wilde incision as a surgical measure because of the numerous disastrous results which he has witnessed follow in the train of this vain dependence, not indeed directly attributable to the incision, but none the less to be imputed to its charge, since reliance was placed upon it and it signally failed to realize or fulfil expectations, hence the sequence of distressing intracranial and other complications.

As a surgical measure it was simply a makeshift, an imperfect substitute for the mastoid operation, and ought long ago to have been abandoned, but like Banquo's ghost "it will not down," and we are ever and again flouted by this truculent spectre, irritating to the progressive and scientific mind and of direful import to suffering and defenseless humanity.

The protracted period of popularity which the Wilde incision has enjoyed is easily understood when we pause for a moment to consider the elements which contributed to establish it in favor. These were the simplicity of the step and the ease with which it was performed. As an operation it commended itself highly to the timid and the slothful practitioner, for while it accomplished but little, it demanded but little! It did not necessitate the technical skill, the surgical knowledge, the instrumental precision, or the moral fortitude required by the more radical and formidable procedure upon the mastoid process, but at the same time it created upon the mind of the patient a profound impression and thereby exalted the dignity and importance of the doctor, flattered his self-esteem, and incidentally accrued to his financial advantage; it was therefore entitled to much consideration and not to be lightly discarded.

*The only legitimate field for the Wilde incision was in the periostitis and mastoiditis of children.* In young patients where the cortex was still thin and all the osseous structures soft and feebly

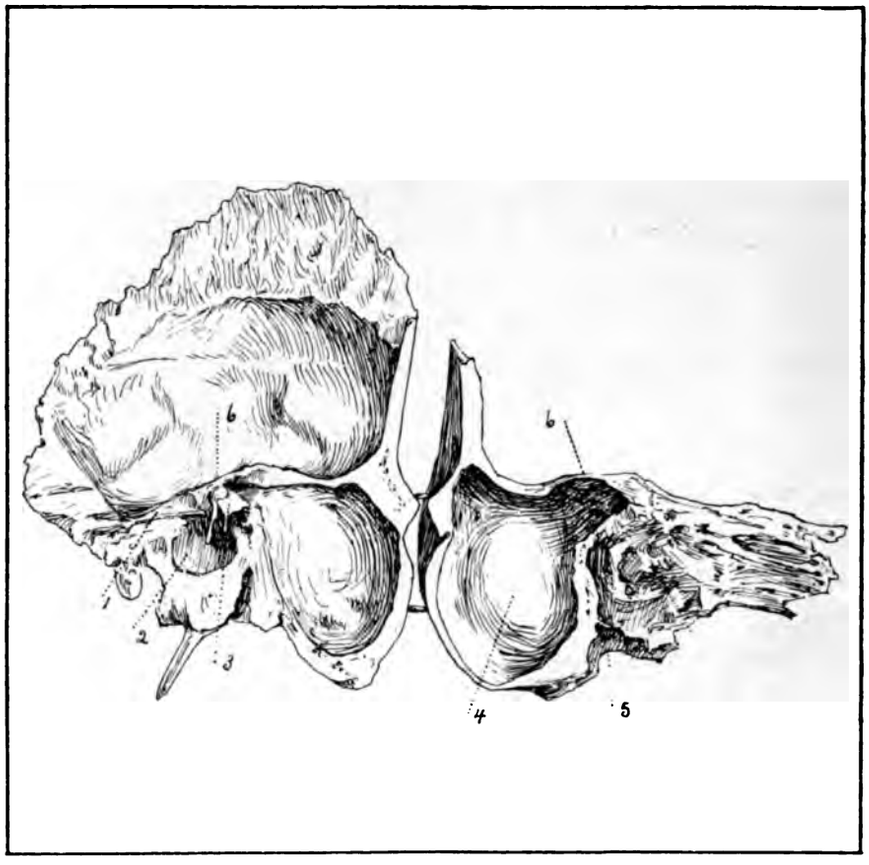
resisting, a suppurative process would often make its way with startling rapidity from the antrum along a narrow fistulous tract until the outer table was perforated, and would furnish the precise indications for the Wilde incision, while the diploic tissue of the as yet undeveloped mastoid process would escape for the most part the ravages of the purulent inflammation. Such were the clinical conditions most favorable for this simple step, and although sclerosis of the mastoid of greater or less extent was a uniform accompaniment of such convalescence, it was unrecognized or unheeded in the gratification at the apparent speedy cure, while any subsequent disability arising therefrom was regarded as an entirely extraneous circumstance.

*The service of the Wilde incision to medical science was moral rather than clinical*, and full credit is rendered the procedure in this ungrudging acknowledgment. The device was promoted at a time when all operations upon the mastoid were stigmatized and deprecated, and it exercised therefore a beneficent influence in disarming hostile criticism and in moulding medical opinion from a position of defiant and uncompromising opposition against, into an attitude of cordial approbation of, operative measures once discarded as pernicious and dangerous. In this capacity chiefly has the Wilde incision contributed to the welfare of humanity, as a preparatory step.

It is perhaps sufficient in concluding a consideration of the Wilde incision to characterize its performance at the present day as a senseless proceeding, for the reason that it is not calculated to reach the source of the disease. Those who insist upon still further prolonging its vogue should reflect that the measure was conceived in error, nurtured in complacent toleration of its utter inadequacy, and is being perpetuated in obstinate disregard of the fundamental principles of surgery.

During the interval between the period of the greatest popu-

## EXPLANATORY NOTE TO PLATE D.




This plate shows:

A right temporal bone which has been so divided as to display the middle ear, with its contents, in relation to the aditus and the cavity of the mastoid process, which in this specimen has been cleanly exenterated.

(1) The tensor tympani muscle.

(2) The membrana tympani.

(3) The position of the malleus and incus in the attic, and the relation of the horizontal process of the incus the aditus and antrum.

(4) The convexity of the inner table, marking the situation of the sigmoid groove just below the knee.

(5) The course and situation of the Fallopian canal with relation to the antrum and tympanum.

(6) The tegmen tympani and antri.

PLATE D.

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larity of the Wilde incision and Schwartze's epoch-marking publication in 1873 (Schwartze and Eysell) of the indications for the mastoid operation and the high degree of success to be anticipated by the employment of chisels and gouges, numerous and varied devices were introduced for perforating the mastoid cortex, with a view to supplementing the incomplete and unsatisfactory results of the periosteal incision.

The first operators with the requisite fortitude to defy the traditional disrepute into which all procedures involving perforation of the mastoid had fallen and to revive the discredited operation of Petit and Jasser upon a rational pathological basis were Turnbull and A. B. Crosby in America and Ludwig Mayer in Germany, each of whom in 1864 perforated the mastoid cortex for the relief of purulent mastoiditis. Crosby, having nothing more suitable at hand in the shape of an instrument and recognizing the urgency of the symptoms, used an ordinary gimlet with favorable result.

No sooner had these courageous converts set at naught the dictum of intolerance and obstinacy than zealous disciples appeared in all lands, but not by any means an innumerable host, for according to Buck (Archives of Ophthal. and Otology, Vol. III, page 173) there had been but thirty-five (35) such operations recorded as late as 1873, in which enumeration the case of Jasser (1776) was included.

The few early recorded procedures upon the mastoid by continental and American operators, while creditable in themselves as individual performances, were not sufficiently numerous to exercise any material influence in moulding public sentiment into a favorable attitude toward such operations; they were calculated rather to emphasize the crudity of technique and incompleteness of equipment of those hardy experimentalists, and a recapitulation of them in detail at the present day is scarcely war-

ranted either by the edification or information which their perusal affords. From 1873 forward, however, until 1885, when the Schwartze procedure had entirely superseded it, perforation of the mastoid cortex was an occurrence of such frequency as to be no longer noteworthy.

The instruments invented for the purpose of penetrating the mastoid process to a sufficient depth to communicate with the antrum when inspected as a matter of curiosity constitute an imposing array and offer an eloquent tribute to the ingenuity of the physician and artisan alike. Every otologist of eminence had at least one and oftentimes several perforators designated by his name, which contrivances took the form of burrs, drills, or trephines. While perhaps no particular appliance is entitled to claim distinctive merit, inasmuch as all were so nearly similar in design, the instrument which found greatest favor with aural surgeons in America, at least, was a drill devised by Dr. A. H. Buck, of New York, which, as far as perforating the bone was concerned, answered the purpose admirably and left little to be desired.

The method of operating for purulent mastoiditis as practiced by Drs. Buck, Gruening, and Roosa in New York, prior to the universal adoption of Schwartze's technique, may be regarded as typical of the procedure as employed elsewhere so long as reliance was placed upon trephining the cortex and subcortical cells, and is briefly here appended as described by Roosa in his book (1885), page 501: "*The incision should be made parallel to the attachment of the auricle from three-quarters of an inch to an inch and a half in length. If there be no fistula and we have decided that dead bone is probably beneath the outer table, a small trephine may be used and the process opened—the periosteum being, of course, first dissected up. The trephine should be worked in a direction, inward, forward, and upward. There can be no posi-*

*tive directions given as to the depth to which the instrument should go.*" Such is the brief and vague description with which the technique of the mastoid operation as performed by trephine and drill is dismissed in the text-book of 1885. Regarding the Schwartze operation the same author says that the method does not commend itself to him—he prefers the drill or trephine.

The operation of opening the mastoid bone with the drill as the writer of this work saw it practiced as late as 1890 was as follows: A curvilinear incision was made about one-quarter of an inch posterior to the post-auricular fold and one and one-half inches in length; the periosteum incised and retracted, exposing a narrow elliptical surface of cortex upon the anterior border of which lay the posterior margin of the bony meatus. The point of election for opening the mastoid was in a situation corresponding closely with the inferior angle of the suprameatal triangle (see Plate A); a three-sixteenths inch drill was then employed in a direction inward, forward, and upward for the purpose of perforating the cortex, the subcortical and mesial cells until an accumulation of pus was encountered and liberated or until communication with the antrum was established. With the penetration of the cortex and the simultaneous evacuation of pus, the operator either desisted entirely from further instrumental procedure or confined his efforts to a very cautious introduction and manipulation of a small curette or spoon and perhaps indulged in similarly unproductive probing. When upon perforating the outer table pus was not at once encountered the drill was forced with a rotating movement deeper into the process until communication with the antrum was established, or, failing that, at a depth of 22 m.m. the drill was discarded in favor of a probe or small curette with which all further investigation was prosecuted. If the antrum was found by either method the operation was considered to have been brought to a successful issue and was terminated by inject-

ing some sterilizing solution through the cortical opening until it appeared in the external auditory meatus, thus affording unmistakable evidence that through drainage had been established; a small rubber drainage tube was then introduced within the opening in the bone, the wound covered with gauze and bandaged, and a cure anticipated after protracted suppuration.

Should it, however, by any chance transpire that notwithstanding the skilful ministrations above recounted, the antrum was not found, at the depth then recognized as the limit of safety, —viz., 22 m.m.,—further search was abandoned in the hope that if pus were contained in the undiscovered antrum or in any accessory mastoid cavity, it would find its way to the artificial opening and accomplish the desired relief. Should nature at this juncture neglect to come to the assistance of otology, already quite at the limit of its resources, the patient was commended to the mercies of his creator—*he had passed beyond the point where surgery could longer succor him.*

The operation with the drill, although a distinctly progressive step and doubtless under favorable circumstances a life-saving measure, was unscientific and attended with needless risk to the patient. It was unscientific for the reason that it did not admit of the instrumental removal at the time of operation of the carious bone within the process; that it did not offer a sufficiently spacious avenue of exit, owing to the narrowness of the artificial opening, for the spontaneous extrusion of the same necrotic tissues should they later separate in the form of sequestra, and, further, it was unscientific because of the impossibility of properly inspecting the interior of the abscess cavity and its limiting osseous boundaries for the purpose of detecting any encroachment upon the integrity of the inner table of the skull.

Its utter uselessness as a medium for the investigation and treatment of intracranial complications of ear disease need scarcely

be mentioned, inasmuch as the hardiest of otologists had not at that time entertained a thought relevant to the surgical possibilities of conditions which then and even until a much later period were by them regarded as inoperable.

The use of the drill was attended with danger for the reason that the structural peculiarities and abnormalities of the temporal bone are very pronounced and frequent, and notwithstanding the rules formulated for the avoidance of injury to the sinus and other intracranial structures, there was always risk associated with the employment of any pointed instrument for perforating the skull, because the point could not be seen and hence was virtually beyond control. The chief danger of course concerned the sigmoid sinus, to the embarrassing vagaries of which, in its choice of situation, any operator who has enjoyed extended experience with mastoid surgery will unhesitatingly testify. (See Plate E.) It really seems as if this vein were designed as a snare and pitfall not for the unwary alone but for the cautious and watchful as well—certain it is that it has confounded the wisdom of the most skilled operator with the same impartiality with which it baffles and dismays the timid beginner. Its inconstancy is notorious, but scarcely sufficiently so to warrant the reproaches which have been heaped upon it and which are in part attributable to the habit of many operators of reporting the course of the sigmoid sinus, in any operation in which they do not wound it, as following a normal direction, while its situation in any operation in which it is injured is invariably chronicled as quite abnormal and very far astray.

That such arraignment is, however, often fully justified Plate E clearly demonstrates, in which the course of the sinus lies in immediate apposition with the posterior wall of the bony meatus and so situated as to insure its violation by either drill or chisel when employed in opening the cortex after the usual method.

The only practical safeguard against accident to the sinus lies in a full realization and constant recollection of the fact that its course may traverse every portion of the mastoid region. Its unexpected appearance should not therefore disconcert the operator. A hint which has often proved serviceable to the author may perhaps with advantage be here imparted—in brachycephalic skulls with narrow and round mastoid processes the sinus is usually situated far forward and superficially, while in dolichocephalic skulls with broad and flat mastoid processes the sinus is usually situated well back and deeply placed.

Any procedure upon the mastoid will be attended with risks to this structure which no method of operating can ever entirely eliminate. So far as it is possible, however, the Schwartze operation has minimized them.

No better indication of the complete disuse into which the employment of the drill as a factor in mastoid surgery has fallen could be presented than to call attention to the fact that Buck, who was so largely instrumental in developing and perfecting the technique of drilling, does not in the last edition of his work (1898) even mention the subject. Like many another antiquated procedure, its day of usefulness is past—it has at length succumbed to the inevitable and has been superseded by a far more admirable and efficient method.

# CHAPTER II.

# THE SCHWARTZE OPERATION.

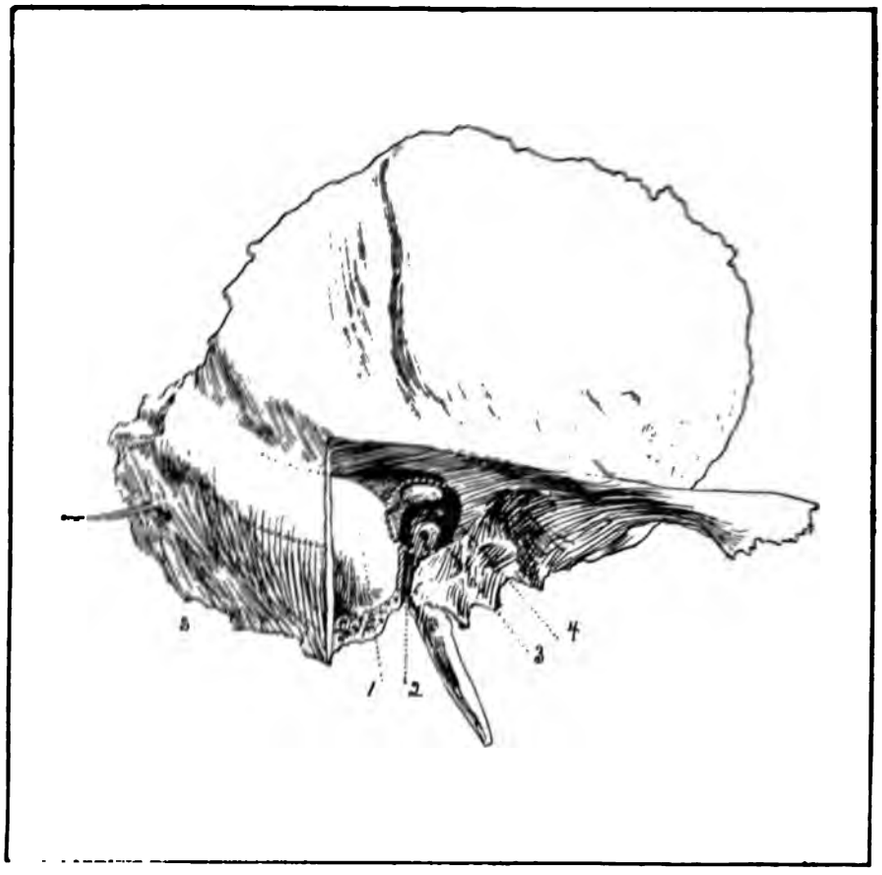
## THE SCHWARTZE OPERATION.

### THE FOUNDATION OF MODERN MASTOID SURGERY.

The manifold imperfections and deficiencies of trephining the mastoid had doubtless appealed to many surgeons during the period of twenty years in which it was the recognized procedure for the relief of suppurative mastoiditis, and the substitution of some more radical measure was a matter of time and expediency only.

Whatever good intentions others may claim to have entertained regarding the improvement of technique do not in the least concern the student who is interested in mastoid chronology; it suffices that while others cogitated, Schwartze executed and consequently enjoys the undisputed distinction of having clearly enunciated the technical and symptomatic principles upon which are based the steps of the modern mastoid operation as performed to-day, and however much we may modify our practice the innovations result in a little more or a little less than Schwartze's operation, but it is simply *Schwartze* still and is not in refutation of his teachings but rather in endorsement and amplification of them.

## EXPLANATORY NOTE TO PLATE E.




This plate shows

A vertical temporal bone, the mastoid process of which is narrow and very convex, and the bony meatus of which is nearly straight, with the plane of the meatal cortex. A portion of the mastoid cortex and cells and all the upper boundary have been removed for the purpose of exposing the entrance of the sigmoid groove in its relation to the field of operation and to the meatus.

The condition of the bone, although very unusual to such as has been encountered in every variety of ear disease and is calculated to embarrass the operator and to put in jeopardy the life of the patient. The concavity of the groove is in contact with the inner cortex which covers in the posterior wall of the bony meatus and which [illegible] in any attempt to [illegible] the [illegible] process after [illegible]

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]

PLATE E.

The chisel as a medium of opening the mastoid bone was first employed by Petit (1674–1760), and again by Forget in 1849, but in each instance in a single case and as an expedient of emergency only and with no proper appreciation of the peculiar appropriateness of the implement for that particular step. So concise and comprehensive were the indications which Schwartze formulated for guidance in the performance of his operation that with slight modifications they would still serve to regulate our clinical conduct.

Schwartze's indications for the performance of his operation are here appended:

1. Acute inflammation of the mastoid process with retention of pus within the mastoid cells when a permanent remission of the symptoms has not been brought about by Wilde's incision. The operation ought to be performed without waiting for symptoms of cerebral irritation or pyæmia.

2. Recurrent swelling of the mastoid region which has undergone temporary recession or has led to abscess formation, with or without fistulous opening in the integument, even though no threatening symptoms exist at the time.

3. When after discharge of an abscess in the mastoid region examination with the probe reveals a fistulous passage in the bone.

4. If with inflammatory processes in the ear, severe pains which resist all other treatment be present in the corresponding side of the head, even though no inflammatory appearances can be detected over the mastoid region.

5. In cases of tedious otorrhœa, the obstinacy of which is not sufficiently accounted for by the condition of the Eustachian tube and tympanum and which resist long-continued and approved treatment on the ordinary lines, the discharge being offensive and mixed with cholesteatomatous masses or bony particles,

even where no conspicuous changes can be discovered in the mastoid region, the author has recourse to operation, experience having taught him that after removal of the cholesteatomatous masses or granulations which are frequently present in the antrum or mastoid cells the otorrhœa ceases and recovery takes place. Sometimes, moreover, small circumscribed areas of inflammation exist in the mastoid process which continue the otorrhœa and are inaccessible to ordinary modes of treatment. These are exposed by the operation and recovery is then brought about more readily.

The technique of the original operation as performed by Schwartze, dependent as it was upon the employment of chisels, gouges, and curettes only, differed very materially from the improved practice of 1900 and was by no means so safe, although apparently a very simple procedure. The rongeur, which has contributed so greatly to safety and expedition in operation, was the product of later and riper experience and was to him in 1873 unknown, nor has he considered it of sufficient importance for mention in his technique as described in the 1894 (the most recent) edition of his work.

Schwartze's technique somewhat abbreviated but containing all the essential or characteristic steps is here presented as translated from his "Handbuch der Ohrenheilkunde," 1894:

"As preparation for the operation a warm bath is prescribed for all, and in the case of men and children the hair is to be cut short over the whole head. A consideration for the cosmetic effect in women demands that the hair shall be cut close for the distance of a hand's breadth only about the affected ear. A similar area is then shaved clean and the skin disinfected, but in cases where inflammatory œdema and subperiosteal abscess are present this part of the preparation is deferred, in order to spare the sensibilities of the patient, until anæsthesia is complete. The incision in the integument is made 1 cm. behind the insertion of the auricle

and dependent upon swelling or infiltration of the soft parts and the size of the mastoid process, from 3 to 6 cm. in length and about parallel with the post-auricular fold. The incision begins at a point 1 cm. above the temporal ridge and extends thence downward quite to the tip of the mastoid process, and in case of cellular infiltration beneath this structure, still further. Should this curvilinear incision when stretched apart by retractors to its full extent, owing to subcutaneous infiltration, prove inadequate for the inspection and uncovering of the bone, an incision at the side or a crucial incision may be required, as also a reflection of the skin flaps.

"After incising the skin all bleeding vessels must be ligated and then the periosteum is to be divided and elevated by means of a periosteotome. No definite rule can be formulated regarding the exact amount of bone necessary to be exposed. This must be regulated to meet the changing pathological conditions, but in any case, the margin of the bony meatus in front and the temporal ridge above must be clearly in view, while posteriorly only so much shall be uncovered as is required for satisfactory inspection of the cortex. When the surface of the mastoid process is fully exposed we have to differentiate between those cases in which the cortex is already partly discolored, softened by caries or the seat of cortical perforation, and those in which we must make our way through a normal or sclerosed cortex.

"With the first condition the affair is very simple because we can employ in our operation a way already preferred by nature —the spot softened by caries is readily opened with a gouge and all bone which appears softened removed with a sharp spoon; the cavity is then disinfected and a drainage tube introduced.

"Narrow fistulous openings in the immediate vicinity of which the bone is often sclerosed like ivory are to be widened with the gouge and hammer sufficiently to admit of the introduction of the

little finger within the mastoid process, in order to inform oneself of the existence of a detached sequestrum. Should such be present sufficient bone is to be removed, with careful regard for the situation of the lateral sinus, to admit of its removal. When no sequestrum can be recognized the cavity of the mastoid is to be cleared of any cheesy, impacted masses of pus, fungus-like granulations, and softened bone by means of the sharp spoon.

"In cases where there is extensive carious excavation of the mastoid process healing will be materially accelerated if considerably more of the shell-like cortex is removed. Should granulations be present in the meatus they are to be removed at the same time by use of the curette and after a thorough irrigation with sublimate solution—1 to 5000—the mastoid cavity is to be drained with a drainage tube. When a small fistulous opening does not communicate immediately with a large carious excavation beneath the cortex but leads into a narrow fistulous tract of eburnated bone the wisest course to pursue will be to introduce a fine probe within the fistulous canal and, chiseling along it, to open the same freely. Sometimes the fistulous tract leads through a long passage of firm bone to a detached sequestrum. The difficulties of the operation are under such circumstances materially increased. When the cortex is found healthy a point is selected for opening the bone from which by the shortest route the antrum can be reached and where nature by spontaneous healing has indicated the way—this is at the base of the mastoid process just beneath the temporal ridge at the level of the upper border of the bony meatus, corresponding with the suprameatal spine and usually 5 to 10 m.m. behind it. At this point the bone shows, as a rule, the minute perforation of a considerable number of nutrient vessels.

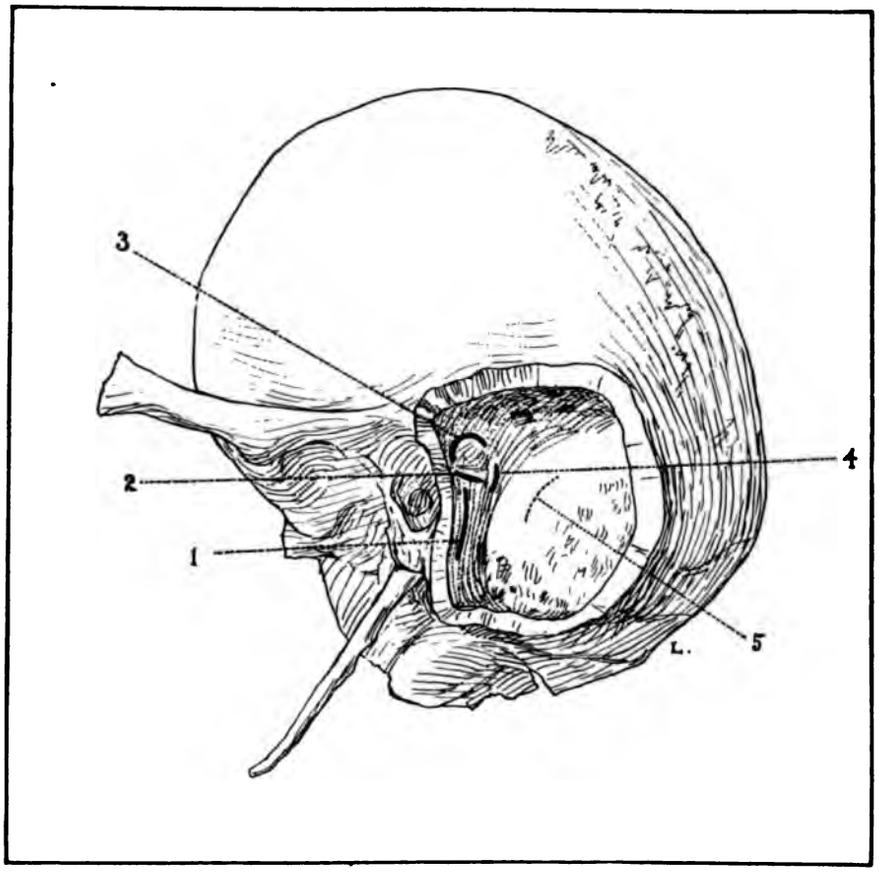
"As the point of chief importance for guidance in the selec-

tion of the site of perforating the bone the linea transversalis takes precedence, associated with which, however, due consideration must be given to the situation of the superior border of the meatus and the suprameatal spine when it is present.

"The opening of the bone at the tip is only to be undertaken when the cortex of that region appears diseased or when a hard infiltrated mass representing the seat of a deep abscess in the neck beneath the tip can be felt. The opening in the cortex must be as large as possible in order that a free inspection of the cavity in the bone may be continuously provided. Whether the opening shall be round or oval is immaterial save as a matter of convenience, although the oval shape is to be preferred in those processes which are narrow or not fully developed. When the opening is round it may include 12 m.m. in width by 12 m.m. in height. When thus large the operator must exercise watchfulness against anatomical anomalies. A thick cortex will add greatly to the difficulties of the operation.

As soon as communication with the cavity in the bone is established a bent probe will speedily determine the direction in which the chiseling must be pursued. The funnel-shaped opening in the bone must have the general direction from without, inward, forward and downward, the tip of the funnel communicating with the antrum. In order to protect the sigmoid sinus the chisel must never be driven in a backward direction, and to prevent opening the middle fossa of the skull the chisel should be held beneath the temporal ridge at about an angle of 45 degrees with the horizontal and driven downward, inward, and forward parallel with the posterior wall of the bony meatus. In the event of establishing communication, immediately after opening the cortex, with a large cavity the result of caries or cholesteatoma, it is advisable *to remove the cortex over the whole extent of the abscess cavity*, by means of which healing will be very materially accelerated.

## EXPLANATORY NOTE TO PLATE F.




This plate shows:

A left temporal bone (the styloid process of which is extraordinarily developed) from which all the cortex and cellular structures of the mastoid process have been removed in order to demonstrate clearly the situation of those important structures which lie within the boundaries of the mastoid process and are hence included in the field of operation. The sigmoid groove (5) is situated far away from the bony meatus in striking contrast with its course in Plate E, in which it overlaps the posterior wall of the bony meatus. The dissection has been carried sufficiently far to expose and open (for purposes of demonstration only) the three semicircular canals, viz., (2) the horizontal or external; (3) the superior; (4) the posterior, in their relation to the meatus. The course of the Fallopian canal (1) in the premastoid lamina is clearly indicated; the facial nerve which traverses it is seldom wounded during the mastoid operation *in this part of its course*, but when damaged is usually lacerated in the *tympanic portion*, where it follows the anterior boundary of the floor of the antrum. The semicircular canals, with the exception of the external, are so deeply situated beneath the floor of the antrum that they are but slightly exposed to the risk of injury in the ordinary operation.

PLATE F.

"In all other cases, especially where the bone is sclerosed, it is superfluous to remove more cortex than is absolutely essential to the establishing of communication with the antrum, the search for which, when not found at a depth of 25 m.m., should be abandoned."

Such is the conservative and cautious measure upon which the operation as now practiced in America was founded and from which clinical considerations and the employment of the rongeur have caused us to digress widely.

The contributions of importance which America has made to mastoid surgery are included chronologically within the last decade, during which period conspicuous services to this branch of otology have been rendered by Bacon, Dench, Gruening, Knapp, Blake, Orne Green, Buck, Roosa, Randall, Jack, McKernon and others. To this illustrious group could with propriety be added numerous other names, especially among the younger contingent—a band of ambitious disciples whose unflagging zeal and steadfastness of purpose are destined in the future to achieve for otology successes which shall perhaps dim the luster of past triumphs.

The Schwartze procedure, as has been shown, did not advocate the removal of the mastoid tip but sought rather its exenteration when disease of the part was recognized, by means of sharp spoons or curettes, leaving the extremity of the process a thimble-shaped shell from the inner surface of which all necrotic products were supposed to have been removed.

Unfortunately experience showed that notwithstanding the diligent use of the curette upon the walls of this pocket-like cavity or pouch there were very likely to remain fragments of dead bone which escaped detection owing to the difficulties of inspecting the cavity, and oftentimes large areas of the undermined cortex, the nutrition of which was impaired at the time of operation,

would die during the course of healing and the wound after closing down to a small opening would remain as the extremity of a fistulous tract which extended to the necrotic portion of the tip. Frequent repetition of this unpleasant experience soon led operators to seek a remedy which should effectually prevent secondary operation, and inasmuch as the difficulty in the majority of instances was found in the tip, it was deemed wise to remove this part of the mastoid at the same time with the upper portion of the structure.

The operator who first suggested and practiced this radical but natural and logical development of Schwartze's procedure was Dr. Emil Gruening, of New York, who has been intimately associated with every step of positive progress in the science, and to whom otology is indebted for many other valuable and practical lessons. Dr. Gruening advised that where the mastoid process was the seat of purulent inflammation *extending beyond the antrum and involving the body of the bone* the tip should be removed as a matter of routine. His recommendation in this regard has been widely although not universally adopted, and great numbers of patients have escaped the pain, discomforts, and delays incident to secondary operation as a result of the general acceptation of his salutary advice.

This modification of Gruening's was the only essential departure from Schwartze's original steps which twenty years of continuous experience had proved. Upon minor details there were, to be sure, regarding which numbers of operators were at variance, but the [illegible] the mastoid cavity as [illegible] originally enunciated, a [illegible] of the [illegible] of the [illegible] of the mastoid.

## CHAPTER III.

# THE COMPLETE MODERN MASTOID OPERATION; A FLAP OPERATION.

## THE COMPLETE MASTOID OPERATION; A FLAP OPERATION.

The mastoid operation as performed to-day in the author's clinic at the New York Eye and Ear Infirmary and at the New York Polyclinic Hospital he has entitled, because of its intent to remove the entire cellular structure of the mastoid apophysis,

"THE COMPLETE MASTOID OPERATION."

This operation differs in two important details from the commonly accepted procedure for mastoid conditions, the significance of which special features the writer proposes to clearly indicate, and while not desirous of overestimating their importance he is equally solicitous that the advantages accruing from their practice shall not be undervalued or disregarded.

The first difference which characterizes the complete operation from the conventional step as elsewhere performed is in the tegumentary incision, which must necessarily provide a flap operation in order that complete removal of the mastoid apophysis may be conveniently and expeditiously accomplished.

The incisions which the author advocates, and which with increasing daily experience commend themselves more highly to his appreciation, are two in number, viz., a primary or curvilinear, and a secondary or linear; they are situated as follows: the primary incision extends from a point one-half inch (½″) below and a little in front of the centre of the mastoid tip, thence upward parallel with and one-quarter inch (¼″) posterior to the post-auricular fold to a point one-half inch (½″) above the attachment of the pinna. (See Plate I.) The secondary incision extends one inch (1″) directly backward toward the occipital protuberance, beginning upon the posterior margin of the primary incision at a point opposite the centre of the external auditory meatus. (See Plate I.) The two incisions are therefore nearly at right angles with one another.

The exact length of these incisions will of course be subject to variation as the necessity for more or less extensive flaps may arise; for example, when very pronounced œdema of the scalp renders difficult the elevation and retraction of the flaps, both incisions may require to be materially lengthened; or to illustrate still further, suppurative mastoiditis may extend very far backward toward the occipital bone or may even involve that structure, in which event the eradication of the necrotic tissues will necessitate the extension of the secondary incision only; whatever requirements the exigencies of the situation may impose, the extension of one or both of the incisions will adequately fulfil the demand.

The reasons which have induced the writer to adopt the flap operation as the routine procedure in mastoiditis, and which are to him convincing in their significance, may be thus briefly summarized: Without doubt the difficulties and many of the dangers as well of the mastoid operation have depended largely upon the inability of the operator to see clearly what he was doing,

owing to the custom of working within a needlessly contracted field, a practice which has until recently been regarded by all otologists as *de rigueur;* this element of embarrassment and uncertainty the flap operation is calculated to entirely eliminate, it contributes therefore in great measure to the simplicity of the procedure, since under such conditions the entire mastoid apophysis is exposed to view at one time, admitting of a much more comprehensive conception of its structural and surgical relations.

The author has also frequently noticed and commented upon the surprising rapidity and regularity with which healing ensues in large wounds of this region made in operating with a similar flap for sinus thrombosis or for posterior purulent extensions, which observation has materially strengthened his conviction of the desirability of the projected step; and further he believes that one-half of the so-called accidents, during the mastoid operation, are occasioned by the operator not seeing clearly what he is doing; most of these dangers an unobstructed view of the field would obviate.

As a result of numerous operations made with various modifications relative to the length and situation of incisions, the measurements above enumerated were at length determined upon and adopted as being most advantageous and practicable in the majority of instances, and after an experience of two hundred and fifty consecutive mastoids operated upon in the clinic and in private practice by flap operation, the writer is still more firmly established in his belief that the procedure is greatly facilitated and simplified by this method, and that healing is moreover remarkably accelerated.

As regards the formation of cicatrices, they are not more extensive or unsightly than the resulting scars of the single curvilinear incision, for which the great dragging upon the edges of the wound by the retractors, necessitated where the simple incision

is employed, in the endeavor to obtain a clear field of operation is in some degree responsible, which detrimental feature is entirely wanting in the flap operation, the borders of which after being reposited lend themselves very kindly to coaptation and speedy union, in the course of which healing the deep fistulous tract, so intractable and annoying and hitherto so frequent, is practically unknown. The one obvious advantage which the flap operation offers—and it speedily becomes indispensable—is an opportunity to see easily, without embarrassment, and at one time, the whole mastoid apophysis, thus insuring a comprehensive view of the operative field, which no single incision, be it stretched never so wide, can possibly supply. (See Plate 5.)

A second and distinct benefit conferred by the flap operation upon the author's cases has been an unquestioned shortening of the duration of post-operative treatment, which consideration alone is of sufficient moment, when fully established, to entitle the procedure, even were it possessed of no other commendable qualities, to careful consideration.

The second difference which characterizes the **COMPLETE MASTOID OPERATION** from the Schwartze operation as modified by Gruening is the removal of the pneumatic spaces and diploic cells at the posterior root of the zygoma.

That these osseous structures, investigation of which is usually disregarded, contribute to the necessity for secondary operation with a degree of frequency greater than is commonly ascribed to them the writer thinks an entirely warrantable assertion, since in every instance where secondary operation has been required in his service (after the tip had been removed at the primary operation) the offending agents were found with uniform regularity, both by means of probing and later by inspection upon reopening the wound, in the anterior superior angle of the suprameatal triangle; in other words, in that portion of the temporal bone which constitutes the posterior root of the zygoma.

That the experience of other surgeons will corroborate this observation seems reasonably certain, inasmuch as the majority of reoperations which the writer has witnessed at the hands of colleagues have, with rare exceptions, exhibited firm, laudable scars, closing both the upper and lower angles of the original operative incision, while at a point a little above the centre of the cicatrix and corresponding with the situation of the antrum a narrow opening presents, which leads by a fistulous tract inward, upward, and forward to a small area of dead bone, the removal of which with sufficient thoroughness to induce healing is seldom accomplished by means of such curetting as can be practiced without anæsthesia, but in most instances demands secondary operation.

Repeated experiences of this nature in his own clinical practice, as well as observation of similarly unsatisfactory results in the work of other competent operators, has induced the author to bestow attention, when operating, upon the thorough investigation of the anterior superior wall of the antrum, which is formed in part by the cellular structures at the root of the zygoma.

Any surgeon who has not habitually opened the pneumatic spaces in this region during his operations upon the mastoid will experience surprise at the extent and depth which they often attain, especially in dolichocephalic skulls (see Plate G), and when he has observed the amount and character of pus and other septic materials which these cavities in many cases of purulent mastoiditis contain, he will no longer wonder that such products when permitted to remain undisturbed within the bone lead with frequency to subsequent death of contiguous structures; *such accumulations have indeed in several instances in the writer's experience caused erosions of the inner table, and been responsible for small epidural abscesses of the middle cranial fossa, while cortical perforations of the root of the zygoma, with accompanying subperi-*

## EXPLANATORY NOTE TO PLATE C.

*This plate shows:*

*A right temporal bone of pure pneumatic variety, the cells of which have developed to a remarkable extent. The specimen is from a dolichocephalic skull, which usually admits of commodious cavities and sinuses, as well as processes.*

*The development of the pneumatic spaces at the posterior root of the zygoma (zygomatic cells) is most extraordinary, extending as they do far upward and also forward as far as the apex of the glenoid fossa; such a cavity would constitute an additional and dangerous focus for the accumulation and retention of pus in the course of suppurative inflammation of the mastoid process. The importance of these cells in the mastoid operation has been habitually disregarded.*

*This bone also furnishes an excellent demonstration of the extent to which the pneumatic spaces encroach upon the occipital bone, the jugular process (5) being comprised entirely of large air cells as far downward and backward as the jugular foramen.* (1) External auditory meatus. (2) Posterior root of zygoma. (3) Mid. root of zygoma and Glaserian fissure. (4) Sigmoid groove. (5) Jugular process of occipital bone. (6) Stylo-mastoid foramen.

PLATE G.

*osteal abscess, are by no means so infrequent as to excite special interest.*

The writer entertains no doubt that many cases which have in the past maintained protracted and unaccountable post-operative temperatures have depended for their systemic manifestations upon the absorption of pus remaining in unopened cells at the root of the zygoma.

The cavity within the root of the zygoma when opened presents in many instances the outlines of a nearly symmetrical cone, the apex of which, inclined upward and forward toward the external angular process of the frontal bone, is lined with hard, white, glistening bone.

As a rule, the cellular structures to be removed in this situation consist of several layers of diploic bone from the subcortical and deep cells, which are continuous with two or three small pneumatic spaces, beyond which one large space is always found constituting the apex of the cone.

When we consider the situation of these cells in their intimate relation with the antrum, aditus, and attic, in which cavities pus accumulates early in the course of suppurative mastoiditis and about which the greatest violence of the attack is often expended, the frequency with which they participate in the inflammatory process should not occasion surprise, but should rather have been anticipated. The thorough removal of the zygomatic cells in conjunction with a similar treatment of the mastoid tip has proved in the hands of the writer an unequivocal success, and he earnestly commends the procedure as a method calculated when conscientiously pursued to produce a satisfactory result in every instance. As a measure of its efficiency he is able to record two hundred and fifty consecutive **COMPLETE MASTOID OPERATIONS** with but one single reoperation to induce healing, and that in a phthisical patient with greatly reduced vital forces, whereas

the preceding two hundred mastoid operations were brought to a successful termination only after eight per cent. had submitted to reoperation.

The writer therefore feels justified in regarding the **COMPLETE MASTOID OPERATION** as a positive assurance of successful healing, and an infallible safeguard against the vexations and annoyances of secondary operation.

The innovations which he advocates appear to him not merely judicious, but essential as well. He fully recognizes, however, that all such measures must withstand the test of experience, which will bestow or withhold its sanction according as results justify or disprove the claim advanced.

# TECHNICAL PORTION.

## CHAPTER IV.

# THE PATHOLOGY OF SUPPURATIVE MASTOIDITIS.

## THE PATHOLOGY OF SUPPURATIVE MASTOIDITIS.

To the conscientious doctor, with a large surgical practice in otology, the fruit of each day's labor is very likely to be a vexatious and worrisome problem, having for its solution the interpretation of some obscure inflammatory manifestation, the contradictory phases of which he despairs of being able to reconcile; and inasmuch as many such problems have their origin in pathological changes of debatable significance, the writer has endeavored to offer an explanation of certain inflammatory appearances in the cellular structures of the mastoid bone, concerning the significance of which opinions have been widely at variance.

Those who are familiar with the pathology of mastoiditis will readily understand why no conscientious operator can consistently leave the mastoid tip and other cellular structures undisturbed or content himself with anything short of the complete operation. For the edification and enlightenment of such readers as are not acquainted with the rational pathology govern-

ing the many and varied manifestations incident to mastoid infection, the appended explanatory pages are offered, in which the writer endeavors to show that ***physical examination of cellular osseous structures cannot determine the question of their vitality,*** and that hence the only safe procedure lies in the removal of all such tissue; also, that infection of the mastoid process, emanating as it does from the antrum, is distributed in great measure by veins and lymphatics as well as by immediate continuity of the lining mucoperiosteum.

Otologists have from time to time indulged in much unsatisfactory and unproductive discussion regarding the nature of the destructive processes which operate in the course of suppuration of the mastoid bone.

Some operators maintain that all cases of mastoid suppuration are to be classified as osteomyelitis, irrespective of their extent; others, again, declare that only those cases may be properly so denominated which progress with extraordinary rapidity and extend beyond the usual limits of mastoid inflammation, that is, backward, into the occipital bone or upward into the squama and zygoma, or into even more remote structures; while still others insist that inasmuch as there are few or no myelin cells in the mastoids of adults that suppurative processes in this region can be regarded as osteomyelitis only in infants, and are otherwise to be properly characterized as simple destructive osteitis. It is probable that much valuable time has been wasted by the parties to this dispute owing to the fact that neither side has clearly defined what they mean by the term "marrow." In order that no such misunderstanding may arise in the interpretation of the author's chapter, he begs to state certain elemental anatomical considerations in reference to the structure of bone.

It is essential to a clear comprehension of the phenomena which constitute the pathological features of acute infectious

osteomyelitis (suppurative mastoiditis) that the reader should fully appreciate the importance of the different structural elements of bone as agents in the propagation and maintenance of inflammatory processes. It may not, therefore, prove entirely unprofitable briefly to recall to mind the structural peculiarities of bone, for with the anatomy of that tissue fresh in memory the changes incident to the course of either a productive or a destructive inflammation are more readily interpreted.

Bone consists of two integral portions, namely, a hard part and a soft part, intimately combined.

"The hard part of the bone is composed of a calcified basement substance arranged in little concentric cylinders about a central canal called an Haversian canal; between these cylinders there are a moderate number of cells whose branches anastomose with one another through holes in the cylinders.

"The soft part of the bone is composed of a stroma of connective tissue containing blood-vessels, lymphatics, and nerves, and certain cells called osteoblasts which appear to be concerned in the formation of bone. The soft part of the bone occurs upon the outside of the bone, in the Haversian canals, and within the bone. It is important to remember that the soft part of the bone lying in the Haversian canals is continuous with that upon the outside of the bone, and also with that within the shaft of the bone." (Bolton: *Notes on General Surgery*, page 10.)

These histological characteristics are equally applicable to long bones like the femur or to flat bones such as compose the cranial walls, or to any part of such bones, as, for example, the mastoid process.

The term marrow, as just indicated, is employed by the writer in a comprehensive sense, to include all the so denominated soft parts—not only the scanty and insignificant number of myelin cells, but all the soft tissues lining the bone spaces as well.

The medullary spaces in bones vary greatly in size. As one extreme may be mentioned the large chambers in the shafts of the long bones like the femur. These are especially designed receptacles for the accumulation and storage of fat and myelin, a commodity which is neither more nor less than a blood-producing element; in other words, a structure which, contrary to the commonly accepted notion, contributes in no respect to the nourishment of the bone which contains it.

As an illustration of the opposite extreme in the size of medullary spaces may be cited the innumerable minute Haversian canals, with their lacunæ and canaliculi, which traverse the cortex of the same long bone. Whether an inflammation involves only the superficial layers of the cortex or attacks the central core or selects the epiphysis of the bone for its prey, the process is the same, *i.e.*, central or peripheral osteomyelitis.

The Haversian system, as is well known, is but scantily developed in all spongy bone, and in those osseous structures in which the cellular spaces are unusually large, as, for example, in the so-called pneumatic mastoids, and the intercellular walls extraordinarily thin, the Haversian system practically disappears, and the entire nutrition of such bone is derived from the delicate and closely investing mucoperiosteum which is distributed throughout its extent. The mucoperiosteum, supporting as it does the nutrient elements of spongy bone, that is, the arteries, veins, lymphatics, and nerves, is found, in that variety of mastoid process which is denominated "diploic," to contain in addition a scanty supply of myelin in the early years of life, which, with advancing age undergoes atrophy and is displaced by fat cells, quite after the manner of the contents of the medullary spaces in the diploic structure of the contiguous bones of the skull.

In infancy and early childhood the soft parts are the pre-

dominating structural elements of bone, and at that period myelin cells are present in considerable quantity, distributed throughout all osseous structures, but as the individual grows and develops the myelin cells disappear completely from many of the bones and are accumulated or stored in a few bones which have been especially adapted to the purpose; to such an extent is this true that in adults myelin in any appreciable quantity is found only in the long bones, the vertebræ, and sternum. Such being the case, it would necessarily follow that if myelin cells alone constituted the marrow of bone then osteomyelitis could occur only in the few bones enumerated as containing this structure in adult life, whereas it is quite indisputable that such destructive inflammation may be present in any bone to which the proper infective agents gain admission.

Every bone in the body contains marrow or endosteum, that is, a soft part upon the integrity of which the life of the bone wholly depends, but there are many bones which contain but few myelin cells and some which, as already noted, in adult life do not contain any.

Now, to what extent are myelin cells present as an ingredient of bone marrow? Marrow has been commonly classified, according to the color which characterizes it, into two varieties, yellow and red; the yellow or fat marrow is much the more abundant, and is found chiefly in the shafts of long bones like the femur. It is composed of 96 per cent. fat, a few myelin cells, and a delicate connective tissue stroma, the endosteum, supporting arteries, veins, lymphatics, nerves, and osteoblasts, constituting in fact the sole elements of nutrition and repair in bone.

The red marrow is deposited in the epiphyses of the long bones, in the ribs, vertebræ, and sternum, and in scantier supply in all bones; as compared with yellow marrow it contains a smaller quantity of fat, a larger proportion of myelin, and a similar endosteum.

In the loose nomenclature which has until recently prevailed in medical literature, the myelin of bone and the marrow of bone have been wrongly used as interchangeable terms; in so far as the greater contains the less, the word "marrow" is correctly used to comprehend myelin as one of its component parts, but it also includes much more; while the word "myelin," when used as a synonym for bone marrow, is dignified with an importance to which it is in no respect entitled.

The confusion is a natural one, and has its origin in the common root derivation of the two words (the Greek μυελός, meaning "marrow").

Myelin was discovered by Virchow in egg yolk, in the nerve substance, and in the red marrow of bone; it occurs in round, oval, and filamentous shaped cells, some scarcely to be distinguished morphologically from white blood cells, and others like the primitive nucleated corpuscles of the embryo which have been regarded as transition forms between myelin cells and red blood corpuscles.

*Is the presence of myelin cells in any respect essential to that inflammation of bone which is known as osteomyelitis?* The writer has supplemented and reinforced his views upon the point by interrogating several prominent surgeons and pathologists, who are unanimous in their opinions that the presence or absence of myelin in the soft part (marrow) of bone exerts no influence whatever on the character or extent of the suppurative process. The idea still prevails that the fatty portion of yellow marrow constitutes the entire substance. This is an error. It is but one ingredient or element of yellow marrow; just as in red marrow the reddish homogeneous material is composed of fat and myelin cells mixed, and does not constitute the entire marrow substance, but only an essential portion of it.

Suppuration in the shaft of the femur has always been considered the ideal illustration of osteomyelitis, and as such we still

regard it, not because of the fact that myelin is present in that situation in any great quantity, for, as a matter of accurate determination, it represents scarcely one per cent. of the volume of such marrow; it is therefore an insignificant factor.

The precise function which myelin cells perform in the bone has never been definitely determined, but in all probability they are simply collected or stored in the marrow spaces of the bone because they there find commodious and well protected quarters in which to remain against a time when the system shall require, either in the vicinity of the bone or elsewhere, a reparative effort, which necessitates the formation of an extra or new supply of red blood cells; it is a well established observation that in anæmia the myelin cells of the red marrow proliferate very rapidly and produce vast numbers of red blood cells, which are contributed to enrich the depleted general circulation. That the myelin cells ever are transformed into osteoblasts, thereby graciously aiding in the repair of any injury or damage to bone, has never been demonstrated. It is, however, well known that, contrary to the opinion generally entertained, these cells contribute in nowise to the nourishment of the bone. They may be regarded, so far as bone is concerned, as unproductive tenantry complacently accepting gratuitous maintenance and entertainment.

The writer has been at some pains to establish the correctness of these views regarding the nature of infective osteomyelitis and finds his attitude endorsed by the most recent works on surgery.

Stimson in his lectures on bone diseases teaches that by the marrow of bone is to be understood not myelin only, but all those soft parts which contribute to its nourishment, and he classifies all destructive inflammation of bone resulting from infection as "acute infectious osteomyelitis."

Delafield and Pruden, in defining osteomyelitis, say, "in most of

the inflammatory processes which affect the bones the medullary matter has an important share, so that many conditions described as osteitis are really osteomyelitis."

Edward H. Nichols, Assistant Professor of Pathology, Harvard Medical School, in his exhaustive monograph on "Infectious Osteomyelitis," 1904, says: "Infective osteomyelitis is an acute suppurative inflammation of the bone; it is not a specific disease, having its own characteristic germ, but it is an acute inflammation that may be produced by any one of a variety of pathogenic microorganisms or by a mixed infection. Any pathogenic organism which can be carried in the blood stream may be deposited in the bone and produce suppuration," but there are certain well-known varieties of bacteria which are most frequently encountered as responsible agents.

The relative order of frequency with which such microorganisms in pure culture appear as infective agents in bone inflammation when all the bones of the body are included in the reckoning is: first, staphylococcus; second, streptococcus; and third, pneumococcus: but when consideration of such infective bacteria is limited to mastoid inflammation only, the infection is more frequently of a mixed type. Nichols expresses the opinion that "streptococcus is usually responsible for more rapid destruction of tissue associated with more pronounced systemic disturbance, while more extensive bone destruction is likely to be encountered when the infection is due to staphylococcus."

The same writer says "the femur and tibia are the bones most frequently attacked, but no bone is exempt, and short long bones, like the phalanges, or flat bones, like the scapula and bones of the cranium, may be affected."

Suppurative osteomyelitis is certainly a more comprehensive and convincing term than destructive osteitis, for the word-

picture which osteomyelitis portrays is graphic and clear and impels a recognition of the anatomical structures involved in the inflammation, viz., ὀστεον, "the hard parts," and μυελός, "the marrow or soft parts." The justification for the use of the second half of the word is found in the circumstance that all infectious inflammations of bone originate in the marrow, which tissue is chiefly affected, its inflammatory manifestations being modified by the presence of the hard parts, which succumb only after death and disintegration of the nutrient soft parts.

"Inflammation of bone occurs in the soft part of the bone, but the inflammation is modified by the presence of the hard part; it is called osteomyelitis whether it occurs at the surface of the bone or deep within it." (Bolton: *Notes on General Surgery*, page 115.) Osteomyelitis may occur in any part of a bone to which bacteria can gain admission, whether conveyed by the blood, admitted through wounds, or transplanted upon a mucoperiosteal surface after the manner in which the antrum often becomes infected from the tympanum. With the progress of inflammation "the soft part of bone becomes congested and swollen, its vessels are dilated and its stroma infiltrated by serum, leucocytes, and red cells; the cells of the stroma may degenerate and perish in moderate numbers and the tissue still maintain its vitality, or, on the other hand, the soft part of the bone dies, *i.e.*, its stroma, vessels, lymphatics, and nerves; it softens, breaks down and is converted into pus owing to the virulence of the infection or lack of tissue resistance. At the same time the matrix of the hard part, which has depended for nourishment upon the vessels of the dead soft part, dies because deprived of its blood supply." (Bolton: *l. c.*, page 116.)

Such is the condition which we encounter in suppurative mastoiditis. As the result of destruction of the soft part, *i.e.*, the mucoperiosteal lining, of any given portion of the mastoid

cells, the hard parts of the corresponding area are robbed of nourishment and die, becoming, forthwith, an irritating foreign body. A process is thereupon instituted for the separation and removal of the dead and offending structures, in the course of which one of three terminations may be anticipated.

1. Spontaneous recovery.

(A) Approximately normal.

(B) With production of new bone. Sclerosed Mastoid. Extrusion of the sequestrum, if it be not too large, through a spontaneous opening in the cortex and integument ensues, with ultimate recovery after a protracted inflammation uninfluenced by surgical interference.

2. Recovery with necrosis.

The dead bone is removed and recovery hastened as the result of successful and timely operation.

3. Death.

(A) Sinus phlebitis
(B) Meningitis } General sepsis.
(C) Cerebral abscess

A proper appreciation of the symptomatology of mastoiditis and prompt recognition of the indications demanding operation have reduced to an inconsiderable number the deaths from sepsis—indeed, in those cases in which the treatment of a suppurative inflammation of the ear has been from the beginning of the attack in the charge of a competent otologist, and in which mastoiditis, in spite of abortive treatment, has supervened, scarcely one per cent. of mortality is to be recorded.

Cortical perforations of the mastoid with subperiosteal accumulations of pus still occur with considerable although diminishing frequency, and while now and again a case is permitted to undergo spontaneous opening of the integument and to drag along through a tardy convalescence (during separation

and extrusion of dead bone) because of the ignorance and obstinacy of the patient or parent, such experiences are most exceptional.

Recourse is had in the vast majority of all cases of suppurative mastoiditis to early operation, and that satisfactory healing may result, a greater unanimity of opinion should exist regarding the extent of the procedure to be instituted, and the author believes, as he has already stated, that the removal of all the cellular structures of the mastoid offers a complete solution of the problem.

It is manifestly impossible to determine macroscopically to just what extent the mucoperiosteal lining of the mastoid cells can be subjected to a necrotic process and still preserve sufficient vitality to undergo repair after the source of infection has been removed, and it is equally difficult to decide when such periosteum is no longer capable of nourishing the bone which it invests.

Not less perplexing to even the most experienced observer is the task of differentiating between medullary bone which is entirely healthy and similar tissue in which molecular death has already begun but in which no discoloration or softening is distinctly recognizable.

It is seldom difficult for an operator to decide regarding the vitality of *cortical bone*, for its scanty blood supply enables him to scrutinize it closely and to appreciate readily any deviation in color from its normal brilliant whiteness; while its well-known density and brittleness offer an additional and unmistakable standard for comparison with any structural changes incident to softening and decay.

With the *cellular structures* of the mastoid, however, the condition is far different, and it is often impossible to differentiate, *as far as color is concerned*, between healthy and diseased bone,

owing to oozing of blood which both obscures the field and stains the cells, rendering abortive the most critical and painstaking inspection.

*The density of the cellular structures* is also a vain dependence, for while the crumbling softness which precedes and accompanies disintegration of bone is readily apparent even to a novice, the finest sense of discrimination may fail in difficult cases to appreciate the difference between the hardness of those cells which are entirely healthy and the firmness of others which depart but slightly from the normal, the nutrition of which, however, is so far impaired that if not removed they will subsequently die.

The macroscopic appearance of the tissue is that of health, wherein the physical signs are misleading, for infection is already present.

The foregoing conditions constitute a surgical dilemma by which we are daily confronted and from the embarrassments of which the only means of certain escape are to be found in the complete exenteration of all the cellular structures of the mastoid process.

The intimate connection between the antrum and the numerous cells contained within the mastoid is, of course, well known, and in the pure pneumatic type of process the communicating channels between the spaces are sufficiently wide to be plainly recognizable and demonstrable upon the most casual inspection.

The muco-periosteum which lines and nourishes the tympanum and antrum performs a similar gracious service for every pneumatic cell and space contained within the mastoid process and by its continuity insures uninterrupted communication between the antrum and the most remote portions of the bone; these structural peculiarities expose the mastoid to in-

fective invasion under circumstances peculiarly favorable to rapid and extensive destruction of tissue.

Recognizing the antrum as the undisputed centre of distribution for infective material throughout the mastoid apophysis, *the method of propagation* from that focus has been by no means clearly demonstrated beyond contention, and we are confronted with a vexatious problem the correct solution of which promises a satisfactory explanation of those obscure and perplexing inflammatory phenomena which are constantly encountered in suppurative mastoiditis and which are concerned with the production of disease of the mastoid process *beyond the boundaries of the antrum.*

These manifestations are the result of:

**1. Immediate extension from contact with inflamed structures.**

**2. Remote extension from contact with inflamed structures, including veins and lymphatics as chief participating agents.**

**3. Extension by metastasis.**

However extraordinary the extent or situation of a suppurative process may be even when it has invaded the most remote part of the temporal bone during the course of purulent otitis media, the apparently anomalous condition admits of explanation by one or other of the before-mentioned methods of propagation. Were it possible for pus contained in the antrum to infect distant portions of the mastoid process by immediate contact of inflamed tissue only, it would still be impracticable, if not impossible, for an operator after opening the antrum and carefully removing the cellular structures contiguous to it upon all sides to determine with certainty that no pus would be found at a distance from the distributing centre simply *because none was recognizable* in the cells opened in its immediate vic-

inity. As has already been stated, the difficulties of differentiating between tissues which are entirely healthy and those in which disease has but recently begun are such as defy the most critical inspection; in view of which well established experience the determination not to seek for pus beyond the borders of the antrum, because the contiguous cells do not display well marked evidences of disease,—namely, discoloration, softening, and the like,—argues rather for the negligence than for the intelligence of the operator.

Infection by immediate continuity of inflamed tissue is but one method of distributing bacteria, although probably the most common and efficacious; it behooves us, therefore, to comprehend clearly how easily pus may become disseminated, not only throughout the mastoid process but to more remote structures as well, and to appreciate that once so deposited it is capable of initiating in its new situation septic processes which speedily establish additional foci of infection.

The second method of dissemination of infective products, by *remote extension from contact with inflamed structures including veins and lymphatics as participating agents*, is responsible for many extraordinary inflammatory manifestations and is susceptible of the following construction.

The muco-periosteum of the tympanum and antrum, as already noted, extends into and lines every cell in the mastoid process; when, therefore, the antrum is the seat of a purulent inflammation the muco periosteum serves as a convenient and commodious avenue along which bacteria may travel to remote cells, where, on the one hand, they often die as the result of phagocytic energy, or, on the other hand, finding conditions favorable to development and multiplication, they institute anew inflammatory processes which terminate in the death of the soft parts and the formation of pus. Coincident with de-

struction of the soft parts, the hard parts of the bone which are nourished thereby die and undergo absorption if the area involved is small, or are separated from the contiguous healthy structures in the form of sequestra if the area involved is large.

The noteworthy feature of these inflammatory changes appears in the fact *that they are encountered at great distances from the distributing infective centre* (*the antrum*), *while the intervening structures which are more directly in the path of infection, and hence more exposed to inflammatory attack, have for some unaccountable reason escaped the ravages of the roaming hoards of bacteria.* With purulent inflammation of the muco-periosteum many veins and lymphatics are involved (phlebitis and lymphangitis), some in greater and some in less extent in proportion to the virulence of the infecting agent which has attacked the wall of the vessel; in many instances when the infection is acute and of great severity destruction of both the soft and hard parts of the bone proceeds with extraordinary rapidity, notwithstanding which the inflammatory process remains circumscribed and exhibits no disposition to invade remote structures.

Under other circumstances, although the intensity of the inflammation is materially less, the veins become infected, the phlebitis extending throughout the entire length of the vessel until it communicates with some large vascular channel, and if, as is not infrequently the case, that channel chances to be the sigmoid sinus, then sinus thrombosis is a most likely consequence, and as a matter of clinical experience the condition just described is the usual ætiological factor in the production of sinus thrombosis as a complication of purulent mastoiditis or of chronic otorrhœa; oftentimes, however, it happily transpires that the infection does not extend in the lumen of the vein as far as the sinus, but is arrested in its progress at the junction of the first anastomosing vein, near which point it undergoes purulent disinte-

gration with the formation of a new abscess and with resulting destruction of surrounding soft and hard parts at a situation perhaps midway between the sinus on the one hand and the original infecting focus on the other; in such manner the agency of the veins becomes manifest as disseminators of infective material to remote points, thus affording an illustration of what is implied by remote extension from contact with inflamed structures.

The lymphatics exercise a similar activity in absorbing and distributing bacteria and toxines.

The third method of disseminating infection from the antrum, namely, by metastasis, while admittedly infrequent in its occurrence, is none the less an occasional manifestation; in corroboration of which assertion we may call to witness certain well authenticated cases in otological literature in which during the progress of suppurative mastoiditis abscesses have appeared in the temporal bone in situations far removed from the suppurating centre and even in bones of the cranium other than the temporal and not connected with it by continuity of structure. In the absence of any history of trauma to account for the presence of such isolated inflammatory processes the only rational explanation of the phenomena is to be sought in the instrumentality of metastases.

*It is no uncommon experience to find circumscribed accumulations of pus scattered here and there throughout the mastoid and surrounded on all sides by healthy tissue.*

These foci represent the coalescence of a number of cells the interosseous subdivisions of which have been eroded and absorbed by the action of pus which has been carried by a vein or lymphatic and deposited in a single pneumatic space, there to exercise its destructive activity first upon the mucous membrane lining and nourishing the surrounding walls, until it is consumed, and then upon the walls themselves until they are softened and

broken down to such an extent that communication with adjoining cells is established, which cellular fusion is productive of purulent foci of varying dimensions and anomalous situations.

Several such cavities may be found with normal bone structure entirely separating them from one another, but doubtless if sufficient time were to elapse these isolated purulent accumulations would cause destruction of the intervening healthy tissue and ultimately constitute one large pus chamber to which all the cellular structures of the mastoid process would fall a prey. It has probably occurred in the experience of every operator, so frequently as no longer to occasion comment or surprise, to find pus in the antrum and thereafter to prosecute a vain search for further purulent collections until the tip is reached, when a large cavity representing the coalescence of the tip with several contiguous cells is found filled with pus and granulations.

In view of incontestable evidence that infective material from the antrum is disseminated over remote and widely separated regions of the mastoid process, not as a rare or noteworthy occurrence, but as a uniform experience, and since the seemingly healthy appearance of tissues contiguous with the antrum is in no respect a reliable guarantee of the integrity of distant structures, a just appreciation of the dangers to which the patient is exposed when the operator contents himself with evacuating pus from the antrum without removing the remaining cellular structures should convince even the most conservative practitioner of the expediency of the complete operation.

## THE PRELIMINARY PREPARATIONS FOR OPERATION.

The technique of the modern operation for purulent inflammation of the mastoid process may for purposes of convenience be considered as comprising three distinct stages, the performance of the procedure lending itself naturally to such simple subdivision, each of which occupies a consecutive and logical position in the progress of the completed operation and is in such order here enumerated.

**FIRST STAGE.**—The procedure upon the soft parts: Comprising preliminary sterilization of the ear and scalp, together with the construction and reflection of the tegumentary flaps.

**SECOND STAGE.**—The procedure upon the hard parts (bone): Comprising the free opening of the antrum and the removal of as much of the mastoid process as the diseased condition of the bone demands.

**THIRD STAGE.**—Final sterilization of operative field with reposition and stitching of the flaps and application of the dressing.

Let us direct our attention now to the first consideration, namely:

The preparation of the ear and scalp preliminary to making the flaps.

For the ordinary mastoid operation the hair should be shaved from the scalp about the ear for an area included within a radius of three inches (3″) from the external auditory meatus as a centre, such exposure of the scalp being under usual conditions amply spacious for the convenient and expeditious prosecution of the needful operative measures. The practice of those surgeons who insist upon shaving the scalp to the median line of the skull is, it appears to the writer, injudicious, judged from the attitude of either physician or patient. If the physician anticipates by such means to sterilize the whole of the scalp, he manifestly fails in the accomplishment of his purpose unless he insists upon shaving the remaining side of the head as well. From the patient's standpoint, particularly should a woman be the individual concerned, the prospect of such a cosmetic disfigurement is entertained with dismay and its accomplishment regarded as nothing short of a calamity. The procedure appears to have little to commend and much to condemn it; moreover, it displays an unnecessary want of consideration for the patient, who is subjected to a needless and protracted mortification. The desired result is as fully attained when the hair is separated by the distance of one inch from the margins of the wound as when four inches intervene.

After removing the hair about the ear as indicated, the scalp should next be thoroughly scrubbed with soap and water and a moderately stiff nail-brush employed with vigor to insure the absolute cleanliness of the skin and the exfoliation of all loose epithelial scales which may have escaped the edge of the razor. The auricle upon both surfaces is treated to a similar scouring,

after which the external auditory canal is carefully cleansed from pus or other foreign and infective material by irrigation with a solution of bichloride of mercury, 1 to 5000, at a temperature of 110° F. or thereabouts, the canal immediately thereafter being sealed by the introduction of a wick of iodoform gauze gently packed in position where it remains until the completion of the operation.

The mastoid and surrounding region together with the unshaven scalp in the immediate vicinity and the neck below are now subjected to energetic rubbing with cotton sponges dipped in a hot solution of bichloride of mercury 1 to 3000; a towel soaked in a similar but stronger solution, 1 to 1000, is so adjusted about the brows and around the occiput as to tightly encircle the head and confine the hair, leaving only the auricle and field of operation uncovered. These surfaces are carefully sponged with alcohol or ether as the operator may prefer, with which final application the performance of cleaning, and so far as possible sterilizing the part to be operated upon, is completed, and having enveloped the patient's neck and chest in a rubber sheet and carefully covered the same with sterile towels, the operation may proceed.

These preparations may with safety be assigned to the care of competent assistants, such skilled attendants, for example, as the operating rooms of our hospitals afford; but in the absence of efficient helpers familiar with the proceedings, it is incumbent upon the operator to devote his personal attention to these details.

A few words at this juncture, although in no respect distinctly applicable to mastoid more than to other surgery, may not prove inopportune, regarding the needful preparations for sterilizing the operator's hands, and also concerning the character of the sponges to be used during the operation.

The most painstaking thoroughness should characterize the cleansing of the hands of the operator, for any negligence upon this score may contribute a needless infective element to the case which can convert a favorable into an unfavorable prognosis, and inasmuch as cleanliness has long been the undisputed surgical shibboleth, any delinquency respecting it should be considered not only as unpardonable but as positively criminal. The hands can be rendered surgically clean by the careful use of green soap and a nail-brush supplemented by equal parts of lime and carbonate of soda or potash conscientiously kneaded into the pores of the skin, the hands being finally immersed for a few moments just previous to beginning the operation in a solution of bichloride of mercury 1 to 2000; or, what is still more desirable, 85 per cent. alcohol.

Many operators are of the opinion that perfect sterilization of the hands is attainable only after a cleansing process so prolonged and tedious as to make it impracticable, merely from the standpoint of time expended, to resterilize, for repeated operations, several times in one afternoon. Such surgeons maintain that the proper solution of the difficulty is to be found in wearing rubber gloves, which can be rendered completely sterile by placing in a steam sterilizer for twenty minutes, and of which a sufficient supply can always be at hand to prevent any delay incident to resterilizing.

In determining the wisdom of adopting rubber gloves for operating no one can refute the contention that more perfect sterilization is thus obtained than can be realized by any process, however prolonged, to which the skin of the hands can be subjected; but one may with propriety question the assertion that such gloves [illegible] interfere with an [illegible] delicacy of technique. Very [illegible] the delicacy

of the tactile sense or especially incommode one in handling instruments or in manipulating tissue, but ill-fitting gloves, from which the elasticity has departed owing to repeated sterilization, are not only an annoyance in operating but a positive hindrance as well.

When cuts or abrasions of the skin render an operator liable to infection, or when a recent operation upon a septic case exposes the patient to similar danger at the hands of the surgeon, there should be no question of the necessity for the use of rubber gloves, but in the absence of such embarrassing conditions the writer prefers to operate with uncovered hands.

Satisfactory and cheap sponges may be quickly prepared by soaking sterile absorbent cotton for a few minutes in a solution of bichloride of mercury 1 to 3000, after which the excess of the solution is squeezed from the cotton, leaving it in damp wads of a size convenient for sponging. These pledgets should be wrapped in a sterile towel and deposited in a covered receptacle until required for use. Dry pads of sterile gauze are equally serviceable for this purpose.

The instruments employed in the operation are to be sterilized by boiling for one half hour in 2 per cent. soda solution.

## CHAPTER VI.

# THE TEGUMENTARY MASTOID INCISIONS FOR THE CONSTRUCTION OF THE FLAPS.

THE MAKING OF THE PRIMARY OR CURVILINEAR AND THE SECONDARY OR LINEAR MASTOID INCISIONS FOR THE CONSTRUCTION OF THE FLAPS CHARACTERIZES THE FIRST STEP OF THE OPERATION.

**The situation of these incisions is clearly indicated by the dotted lines (1–1 and 2) appearing upon the mastoid and post-mastoid regions in PLATE I.**

**The primary incision (1–1) is made one-quarter of an inch (¼″) posterior to and parallel with the general direction of the post-auricular fold, deviating slightly at each extremity and extending from a point one-half inch (½″) below the tip of the mastoid process, beginning nearly vertically beneath the attachment of the lobule, upward to a point one-half inch (½″) above and the same distance posterior to the attachment of the pinna. (PLATE I.) The length of this incision will manifestly vary greatly with the discrepancies in size and shape of individual heads. The surgical landmarks just enumerated are, however, fixed quantities and should serve as satisfactory guides.**

**The secondary or linear incision begins upon the posterior margin of the primary incision immediately behind the centre of the external auditory meatus and extends thence one inch (1″) directly backward toward the occipital protuberance. (PLATE I.)**

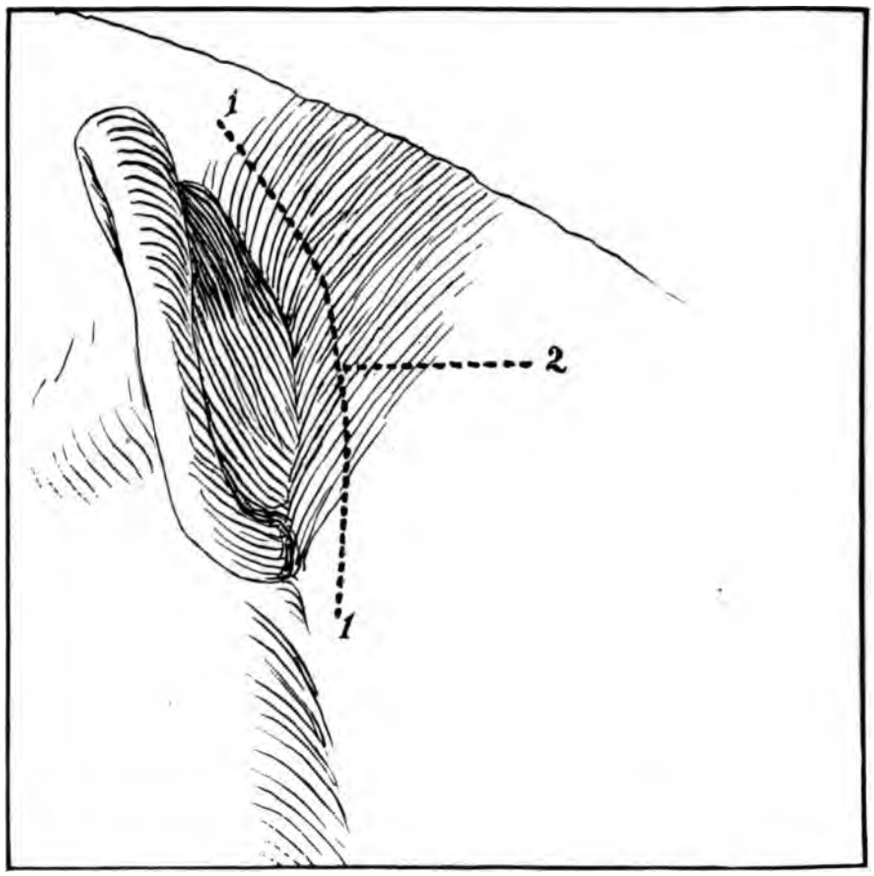
Several important considerations suggest themselves for discussion in connection with the subject of mastoid incisions, the attitude of the writer toward which has been assumed only after considerable experience in operating and after mature reflection upon the advantages and disadvantages of the hitherto accepted method which he has found so frequently inadequate and so uniformly inconvenient as to finally determine him upon the radical departure in making the incisions which characterizes this description of the mastoid operation and which PLATES II and III so graphically depict.

The primary incision should invariably be made from below upward, the operator standing at the head of the table and behind the patient, the advantages of which method and position are obvious. The surgeon is thus afforded by the patient's skull throughout the full length of the incision, a firm, regular, and unyielding support for his hand, securing thereby perfect control of the knife, an advantage which should appeal to every one and which is conspicuously wanting where the operator stands in front of the patient and makes the incision from above downward, indeed, under such circumstances the completion of the incision is attended with material inconvenience and some risk, for, at the point where the soft tissues below the tip of the mastoid process are divided and where the greatest steadiness of hand is imperative to its proper performance, there is either no support at all, or, at best, only the unsubstantial and yielding structures of the neck are to be relied upon, the relation of which to the shoulder in a recumbent patient is such as to impede rather than facilitate the movements of the operator.

The position of the knife in the hand of the surgeon is under ordinary circumstances a matter of no especial significance; the greatest practical utility will be found in holding it in much the same manner as a pen is held in writing, thus the force imparted to the stroke can be regulated and the direction controlled. We frequently, however, encounter mastoid conditions in which the inclination of the blade in making the incision is a matter of considerable importance. Such cases are found in babies, young children, and occasionally in adults, who present themselves with fluctuating swellings behind the ear containing subperiosteal accumulations of pus with large or small cortical perforations of the mastoid process. The writer has operated upon many cases of this kind, several of which have exhibited large perforations of the cortex with destruction of the diploic bone beneath, situated immediately over the sigmoid sinus, which great vascular channel was thus deprived of its bony protection and exposed to the danger of being wounded when the incision was made through the feebly resisting integument. That such a catastrophe may be averted, *the knife should be held, in every case where there is a subperiosteal abscess, with its edge as nearly as possible horizontal with the cutaneous surface* and, with a sawing motion, carried carefully down to the bone without force or haste. When this method is employed there is no chance that the knife will injure the sinus wall, for the horizontal blade cannot enter an opening in the bone, at least to any appreciable depth, while, should the incision through the tumefied tissues be made with the point of the knife nearly vertical to the bone, as is certainly more convenient, the prospect of puncturing the sinus wall or the dura elsewhere must be regarded as a by no means remote contingency.

Still another element of danger suggests itself and may be appropriately mentioned before abandoning the subject, in con-

## EXPLANATORY NOTE TO PLATE I.



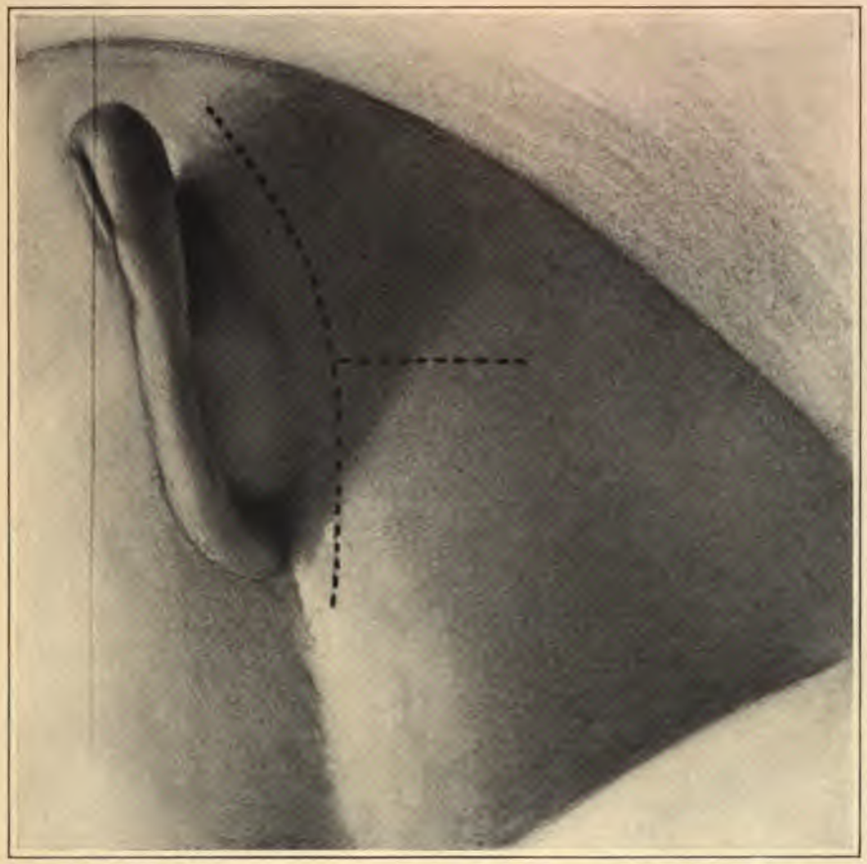

The left ear and temporo-mastoid region are here presented, the hair having been shaved from that portion of the scalp included within a radius of three inches from the external auditory meatus as a centre; within this area the field of operation in the modern classical procedure is contained.

The dotted lines indicate the situation and direction of the primary and secondary mastoid incisions made for the construction of the anterior and posterior flaps.

The primary or curvilinear incision (1–1) is made one quarter inch (¼″) posterior to and parallel with the general contour of the post-auricular fold, deviating slightly at each extremity and extending from a point one-half inch (½″) below the tip of the mastoid process, nearly vertically beneath the attachment of the lobule, upward to a point one-half inch (½″) above, and the same distance posterior to the attachment of the auricle.

The secondary or linear incision (2) begins upon the posterior margin of the primary incision, immediately behind the centre of the external auditory meatus, and extends thence one inch (1″) directly backward toward the occipital protuberance.

PLATE No. 1.



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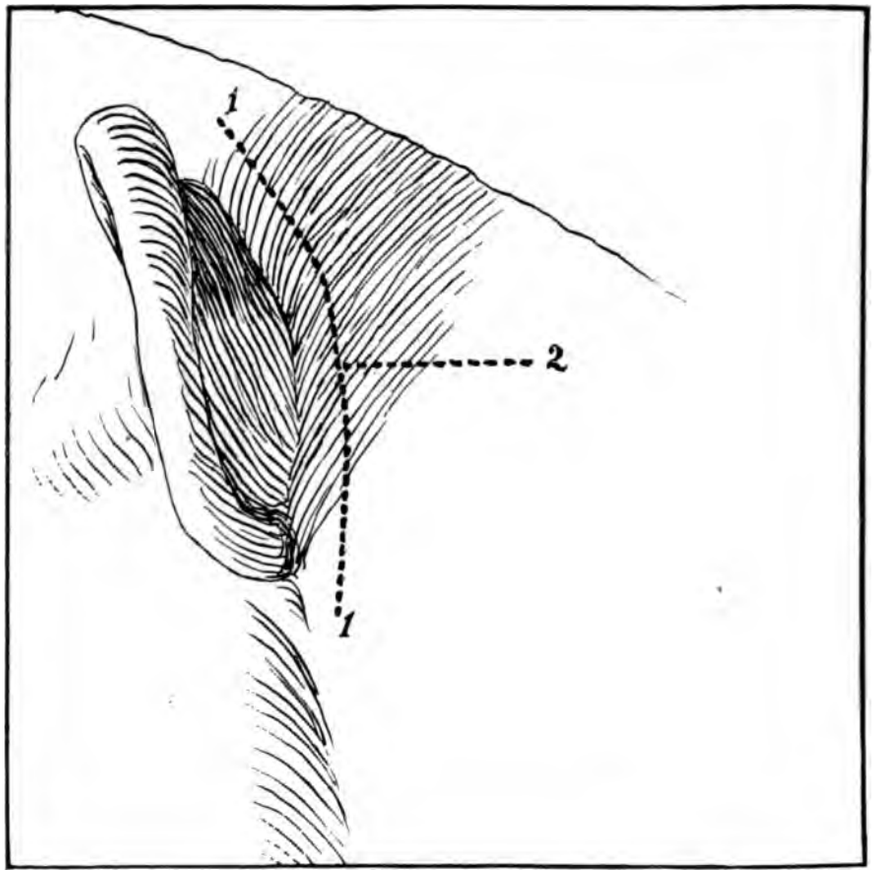
nection with secondary mastoid operations for delayed or incomplete healing due to the presence of carious bone in the wound. This warning has especial reference to cases which have had their primary operation at the hands of some surgeon other than the one to whose lot the secondary procedure falls and who is embarrassed by ignorance concerning the extent to which the mastoid structures were removed during the first operation. He finds perhaps a small unclosed wound or fistulous opening at one extremity of a firm, sunken, and adherent cicatrix. In order properly to meet the indications in such a condition it is incumbent upon the operator to reopen the wound sufficiently wide to admit of careful investigation, that he may assure himself of the complete eradication of the offending material. Now, it is quite possible that in the primary operation the inner bony table constituting the sigmoid groove or the floor of the middle fossa was removed and the sunken scar which composes the healed portion of the wound is consequently firmly adherent to the dura in one or both of these situations; under such circumstances an incision extended through the scar from the unclosed opening, a part or the entire length of the cicatrix, would be a perilous proceeding and obviously fraught with great risk to the adjacent intracranial structures. That this suggestion is not merely fanciful or improbable is attested by a recent experience of one of New York's most distinguished aural surgeons and reported by him at the Academy of Medicine. He was requested to reoperate in a case which had failed to heal at the hands of a colleague, and with his first incision in the adherent cicatrix opened the wall of the sigmoid sinus; the hemorrhage was naturally tremendous and unexpected, but the surgeon was a man of wide experience and of great fortitude and resource. He quickly controlled the bleeding, completed his operation under great difficulties, and his patient recovered, with, however, the oblitera-

## EXPLANATORY NOTE TO PLATE I.




The left ear and temporo-mastoid region are here presented, the hair having been shaved from that portion of the scalp included within a radius of three inches from the external auditory meatus as a centre; within this area the field of operation in the modern classical procedure is contained.

The dotted lines indicate the situation and direction of the primary and secondary mastoid incisions made for the construction of the anterior and posterior flaps.

The primary or curvilinear incision (1—1) is made one-quarter inch ($\frac{1}{4}$″) posterior to and parallel with the general contour of the post-auricular fold, deviating slightly at each extremity and extending from a point one-half inch ($\frac{1}{2}$″) below the tip of the mastoid process, nearly vertically beneath the attachment of the lobule, upward to a point one-half inch ($\frac{1}{2}$″) above, and the same distance posterior to the attachment of the auricle.

The secondary or linear incision (2) begins upon the posterior margin of the primary incision, immediately behind the centre of the external auditory meatus, and extends thence one inch (1″) directly backward toward the occipital protuberance.

PLATE No. 1.

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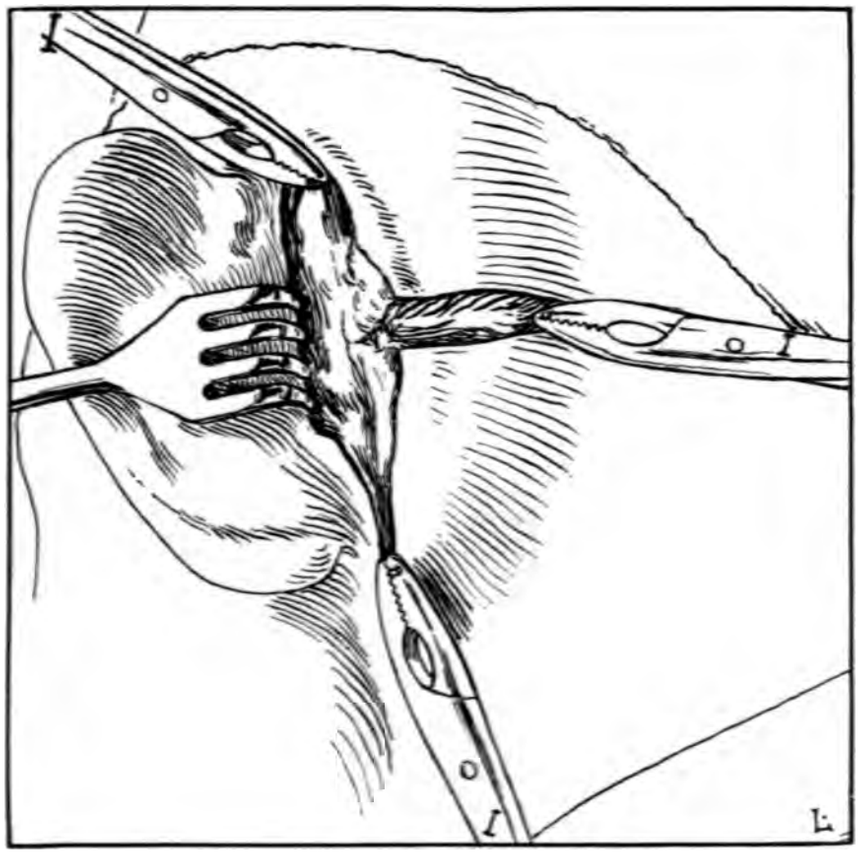
## EXPLANATORY NOTE TO PLATE II.

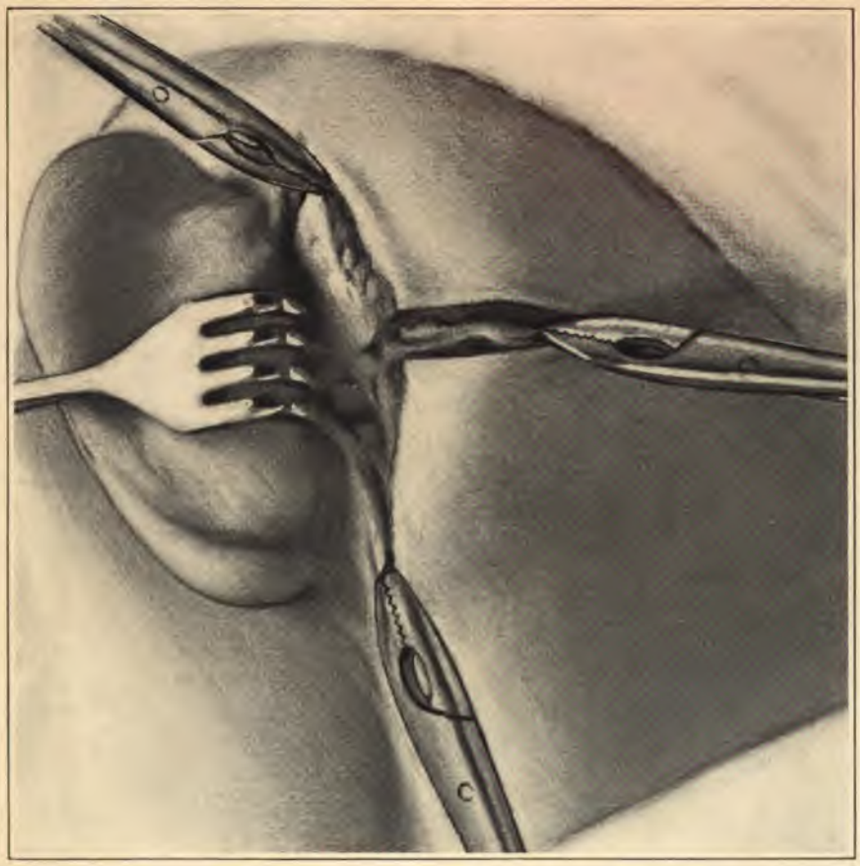


This plate shows the completed incisions by which the flaps are constructed and illustrates the gaping of the wound incident to the retraction of the integument when the periosteum still closely invests the bone.

The skin of the anterior flap is drawn forward by means of a retractor, thus exposing more freely the connective tissue and periosteum beneath.

Several artery clamps (r—r—r) are represented as applied in situations in which vessels of sufficient size to occasion bothersome hemorrhage are apt to be encountered; the clamps can be so placed as to offer but slight inconvenience to manipulation in the operative field, and can be dispensed with entirely if desired after ligating the vessels; oftentimes momentary compression alone is sufficient to check the bleeding without the employment of ligatures.

PLATE No. 2.



manner renders difficult an adequate exposure of the tip for operative investigation, even although the flaps are dragged forcibly apart by retractors.

The second noticeable fault is the tendency to fritter away valuable time in needlessly arresting insignificant hemorrhage from superficial vessels of the integument; a procedure which is quite useless, for deeper and larger vessels must subsequently be divided when the incision is carried through the muscular tissue and periosteum, whereupon the measures already instituted for controlling bleeding must be repeated.

In no more conspicuous manner perhaps can a beginner call attention to his operative deficiencies and lack of confidence than by expending valuable time and extravagant care upon an insignificant and entirely unimportant detail like the arrest of superficial hemorrhage; such unreasonable concern begets in the mind of the sophisticated observer a suspicion that in the event of encountering serious hemorrhage, the operator would fall a victim to a bad attack of "rattles."

The same general deduction is applicable during an operation to every unproductive expenditure of effort which is quite disproportionate to any possible beneficial result which such laborious exertion can produce. The reader should not infer from these observations that attention to details is an evidence of inexperience and want of confidence upon the part of the operator, and that a premium is therefore to be put upon negligence and slovenly practice; far from it, for the writer recognizes fully that a capacity for mastering details is an endowment akin to genius.

The warning is directed against unreasonable and wearisome solicitude concerning unnecessary and unproductive details.

# CHAPTER VII.

## THE ELEVATION OF THE PERIOSTEUM AND THE RETRACTION AND REFLECTION OF THE FLAPS.

## THE ELEVATION OF THE PERIOSTEUM AND THE RETRACTION AND REFLECTION OF THE FLAPS CHARACTERIZE THE SECOND STEP OF THE OPERATION.

**The flaps with their attached periosteum should be reflected in the following order: The superior posterior flap (PLATE III, No. 4) is first reflected, for the reason that to an operator standing behind the patient it is the most accessible; also because of the facility with which it is accomplished, the periosteum adhering but loosely to the bone; the flap is drawn upward and backward and reflected upon itself. The anterior flap (PLATE III, No. 6) next demands attention, and its upper two-thirds ($\frac{2}{3}$) are easily detached while the lower one-third ($\frac{1}{3}$), owing to the insertion of the tendon of the sterno-mastoid muscle, requires the exhibition of considerable force for its separation; lastly the inferior posterior flap (PLATE III, No. 5) should be displaced and reflected after the manner of its superior fellow.**

The suggestion that the periosteum is a valuable tissue

which should be carefully preserved during the mastoid operation for its regenerative and nutrient properties would appear to savor of gratuitous advice. Not so, however, for judging by the method employed by some operators in its elevation, they seem actuated by a determination to destroy every particle of this investing membrane in their unskilled efforts at denuding the bone, apparently failing to realize that it could ever thereafter be of any service, and as a rule after it has experienced such violent ministrations it must be admitted that its utility has ceased. Just why a procedure which is in every respect adequate and which is easy of performance should not commend itself to the approbation of all, is a problem upon which it is idle to speculate; certain it is, however, that no uniformity of method is practiced in elevating the periosteum, and this factor becomes, therefore, a significant one among the numerous elements of faulty operative technique.

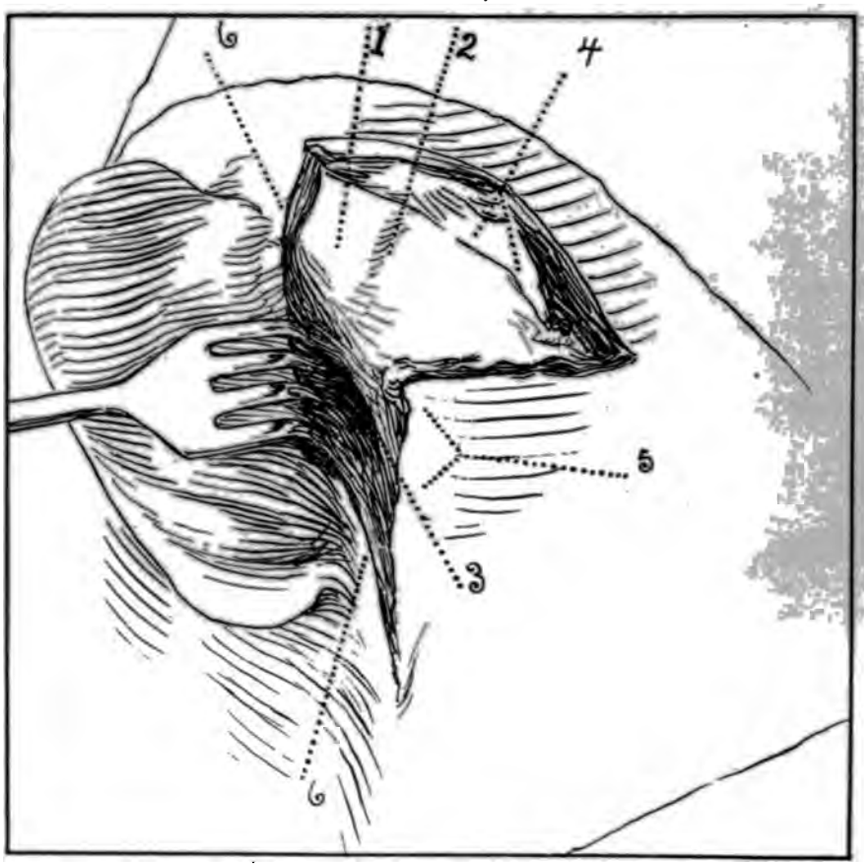
The periosteum can be most rapidly and conveniently elevated and in such manner as to economize tissue by using Langenbeck's periosteotome, which is shaped like a hoe and hence only admits of being used with its edge vertical to the bone. This instrument is to be highly commended both for its practical efficiency and because it renders impossible much of the mutilation to which these structures are often subjected by the incorrect use of the Politzer and other raspatories. A *periosteotome should always be used so that its edge is applied at right angles to the bone and to the incision in the periosteum*, a small section of which having been carefully detached from the bone will serve as a starting-point for the complete denudation of the mastoid apophysis; the periosteum when once properly loosened will readily roll up in advance of the pushing instrument, and that too with the employment of but little force until an area is encountered over which owing to inflammatory ad-

hesions the attachment is very firm, or until the periosteum is perforated by the tendinous insertion of some muscle; at such points considerable force will be required to expose the bone, but if the operator is contented to "make haste slowly" a satisfactory completion of the step, even in the face of such obstacles, is soon realized.

The retraction and reflection of the flaps is most expeditiously and easily accomplished by an operator standing behind the patient's head, in the following order and manner; the superior posterior flap (PLATE III, No. 4) is first reflected for the reason that it is most accessible, and also because the periosteum which covers this portion of the temporal bone is very loosely attached, not being penetrated by the tendinous insertion of any muscles; the method of raising the flap is as follows: with the Langenbeck right-angled periosteotome if obtainable (or if not, with some other held at right angles to the bone) pry the apex of the flap, with its attached periosteum, loose until it begins to roll off the bone, when with an easy pulling motion it can be readily retracted as far upward and backward as the limits of the tegumentary incision permit; thereupon the flap should be sharply bent upon itself (PLATE III, No. 4), in which reflected position it remains fixed during the operation without the aid of mechanical support.

The anterior flap (PLATE III, No. 6) is next attacked and loosened without difficulty from the upper half of its attachment by pushing with the periosteotome, firmly applied to the bone, as far forward as the brim of the bony auditory meatus; the lower half of the flap clings very tightly to the bone, the tendon of the sterno-mastoid muscle being so disposed as to offer most effectual resistance to any effort at detaching it; at the mastoid tip indeed it often defies the most forcible use of the periosteotome and necessitates division of the tendon close to the bone

## EXPLANATORY NOTE TO PLATE III.

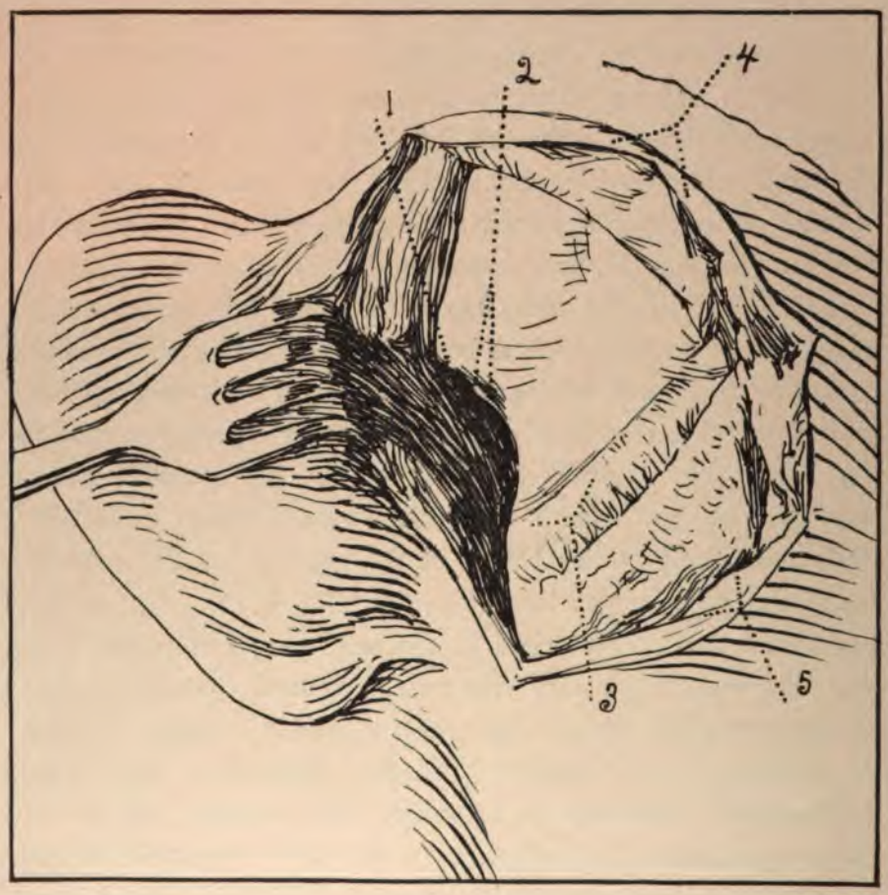



This plate shows the first distinctive step in the elevation and reflection of the flaps: the superior half of the posterior flap is detached from the bone and folded upward and backward, thus exposing to view a portion of the squama (1) and temporal ridge (2), together with the superoposterior segment of the bony meatus (3). The glossy under surface of the flap (4) indicates plainly how perfectly the integrity of the periosteum has been preserved, with regard to its nutrient properties when reapplied to the bone at the completion of the operation. (5) The inferior half of the posterior flap. (6) The anterior flap.

PLATE No. 3.

with scissors; as the complete exposure of the tip in the further progress of the operation will require such division in any case, its performance at this stage need not be delayed or regarded as an unfortunate necessity; this flap must be drawn aside during the operation by a retractor (PLATE IV, *et al.*) held by an assistant, in which position the fibro-cartilaginous canal is clearly exposed to view. Lastly the inferior-posterior flap should be displaced downward and backward and reflected after the manner of its superior fellow, similarly to which it maintains its position unsupported, thus dispensing with the use of a retractor (PLATE IV, No. 5); this flap is elevated with greater difficulty than either of the others because its periosteal lining is penetrated by the broad tendons of the sterno-mastoid and splenius capitis muscles respectively which are very firmly attached to the bone. The uppermost portion of the flap is rolled downward and backward with the periosteotome without great difficulty until the posterior border of the mastoid process with the occipital groove comes into view (PLATE V, No. 6); at this point care must be exercised in the employment of instruments, since the mastoid emissary vein usually emerges from its foramen in this immediate vicinity and caution should be enjoined upon an operator lest, disregarding surgical landmarks, this vessel be needlessly wounded or ruptured. The scissors will be required to separate the tendons from the extreme mastoid tip and to insure the absence of tension upon the flap which would interfere with its successful reflection; the manœuvre of clearing the tip of its apical fibres should be thoroughly performed with scissors curved upon the flat; some threads of tendon will otherwise adhere, both obscuring the field of operation and likewise serving as a menace to the cellular structures of the neck below the mastoid, the nature of which danger is best illustrated as follows: When with the chisel or rongeur the cortex at the tip is

## EXPLANATORY NOTE TO PLATE IV.




This plate shows the displacement forward of the anterior flap and auricle, the position of these structures being maintained by the employment of a retractor; the retraction of the anterior flap brings into clearer view the supero-posterior segment of the bony meatus (1), together with the suprameatal spine and fossa (2); the spine is, in this process, almost rudimentary, the fossa is of the usual size; the anterior border of the mastoid apophyses is exposed as far downward as the oblique insertion of the sterno-mastoid tendon (3), beneath which the contour of the mastoid tip is plainly recognizable.

The lower half of the mastoid process is still invested by periosteum, which the tendons of the sterno-mastoid and splenius capitis muscles penetrate in search of bony attachment.

PLATE No. 4.

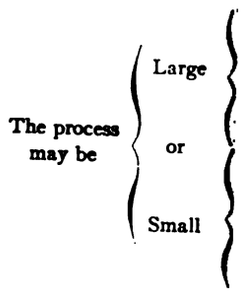
cut away these attached fibres cling tenaciously to the bone and the operator, displaying irritation that the rongeur does not cleanly bite off the structures included between its jaws, is apt to pull or wrench the instrument free of its entanglement and thereby oftentimes to drag out from the neck long thin strips of muscular tissue and deep fascia which thus open channels for the entrance of infective products escaping from the wound above. In the experience of the writer with his own cases and with those of others a disregard of the simple procedure of freeing the tip from these few fibres has been responsible for occasional severe attacks of cellulitis of the neck which were productive of pain, temperature, and anxiety upon the part of the patient and which subjected the surgeon to embarrassing criticism at least, and perhaps to censure as well; these annoyances a little judicious precaution would have obviated.

The retraction of the flaps can always be satisfactorily accomplished after the manner just described except when, owing to œdema and swelling of the mastoid region, the scalp has lost its pliability, under which circumstances a sufficient exposure of the field of operation is with difficulty maintained and adequate reflection of the flaps is prevented. The most effective means of correcting this rigidity will be found in extending the primary incision a short distance further downward and the secondary incision a proportionately increased distance backward, thus insuring additional freedom of movement to compensate for the absence of flexibility resulting from the swelling of the scalp; in case the extended incisions should not entirely liberate the flaps a retractor in the hands of an assistant must then supply the necessary support.

The mastoid apophysis having been completely exposed (PLATE V) many features of interest and importance present themselves for consideration before any attempt at opening the

bone should be instituted. The experienced operator will recognize at a glance and make instant mental record of a host of facts, for future guidance during the progress of the operation, which infallibly escape the attention of the inexperienced beginner; this comprehensive acquaintance with the surgical anatomy of the region qualifies the competent surgeon to proceed with confidence in his own powers and with safety to the patient, whereas the exhibition of similar complacency by an unskilled hand would invite inevitable disaster. The comparative ease with which a finished operator performs his work is a misleading object-lesson to the superficial observer, who uniformly fails to comprehend the fundamental principle involved, namely, *that the distinctive attribute of perfect technique is simplicity;* hence it happens with the mastoid, as with many another operation, that an erroneous impression prevails regarding the ease and safety with which it may be performed, which conception, based as it is upon a misapprehension of the facts, is responsible for the indefensible position in which physicians will find themselves placed when, relying upon such belief, they undertake the operation with insufficient surgical knowledge, inadequate equipment, and faulty technique and are awakened to a full realization of their incapacity only when they have inexcusably jeopardized the life of some confiding patient.

The shape and size of the mastoid process should first engage the attention of the operator, ***inasmuch as the external conformation of the bone oftentimes furnishes a valuable hint of its internal structural peculiarities and may serve as a guide to protect important intracranial structures from injury during the removal of the diploic and pneumatic tissue.*** The processes exhibit great disparity in size and remarkable variation in shape in skulls of individuals of every age, children and fully developed adults alike included, and when the method of completely


The process may be
Large
or
Small

exposing the field of operation as advocated by the writer, is practiced, a comprehensive view is afforded not momentarily only but throughout the course of the operation which enables one to estimate properly the relative values of size and contour.

This is in striking contrast to the embarrassment experienced with the contracted area exhibited when the single curvilinear incision is employed, in which event no reliable impression can be formed of the exact proportions for the reason that never at the same moment are all parts of the apophysis presented to view. Such deductions as size and shape may reasonably warrant, so far as they admit of formulation by chart, will be found in the appended table.

Where the process is large it may be expected that a moderate distance will separate from one another those essential structures contained within it which it is imperative shall escape injury, while a small process implies that the same structures are included within a very limited area and hence lie in closer proximity to one another; in a young child, for example, the sigmoid sinus, the dura of the middle fossa, the facial nerve, the external semicircular canal, and the antrum may all be included within a circle of one-third of an inch diameter or less; the employment of instruments within such restricted limits must necessarily be attended with great caution.

When the process is broad and flat the sinus is usually situated very deeply beneath the cortex and diploic tissue and at a considerable distance posterior to the bony meatus; the antrum will be found within the boundaries of the suprameatal triangle (PLATE V) and is generally spacious, broad, and shallow. When the process is round and narrow the sinus frequently lies very superficially with relation to the cortex and approaches closely to the bony meatus, in which location it is liable to be wounded early in the course of the operation, particularly should

the initial opening in the bone be made after the manner commonly employed in that procedure. The antrum owing to the encroachment of the sigmoid groove upon the bony meatus is frequently contracted and may be crowded upward and forward until it occupies a situation above and in front of its normal position, in rare instances even being so far displaced that prolonged search has disclosed it lying almost vertically above the bony canal and between the auditory plate and the floor of the middle fossa in the situation usually occupied by Kirchner's cells. The cortices of those mastoid processes which are narrow and round descend very abruptly into the bony meatus (PLATE B), with the posterior wall of which they are continuous, while in those apophyses which are broad and flat the outer table, as a rule, slopes very gradually to its junction with the wall (PLATE A); in the first instance there will be a well-defined rim or brim to the meatus which in the second instance is conspicuously wanting. The significance of the sharply outlined rim and the nearly vertical wall of the meatus is merely contributory evidence of the probability that the sigmoid groove pursues a course far forward in the bone.

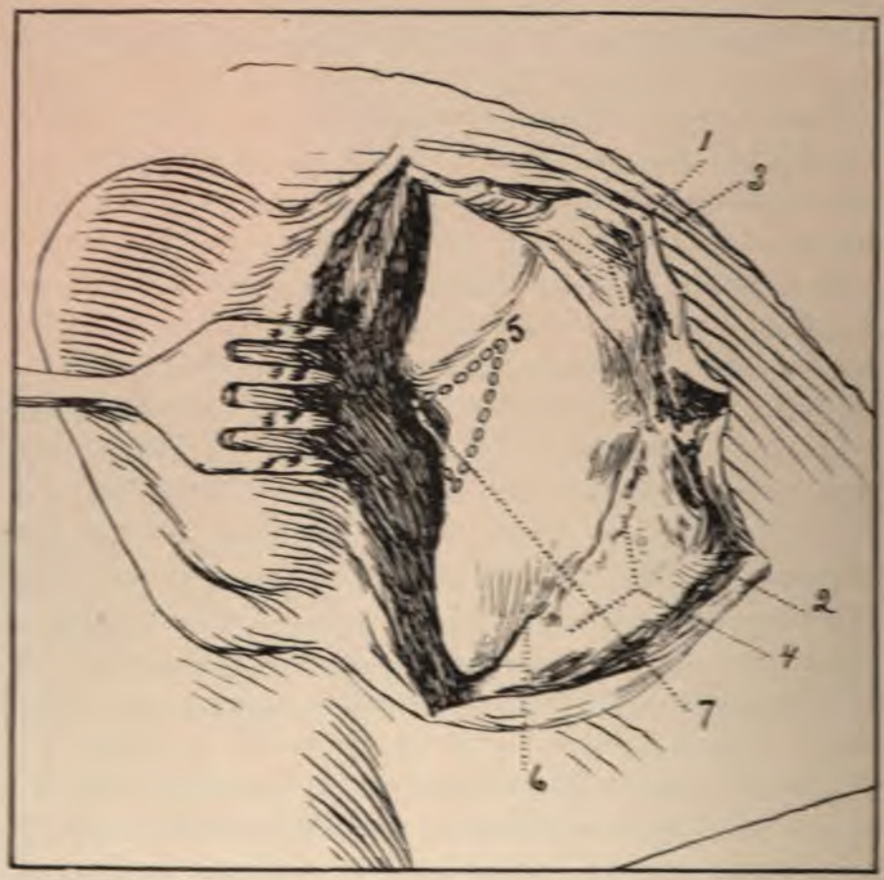
The position and size of the suprameatal spine and fossa should be noted; these are usually situated upon the brim of the meatus within the suprameatal triangle; although never large, they vary considerably in size, being oftentimes only rudimentary; they concern the operator merely as supplementary guides to the site of the antrum, a service of small importance when once the boundaries of the suprameatal triangle are established and observed.

The temporal ridge is an important surgical landmark, indicating as it does the floor of the middle cranial fossa; caution should, therefore, be exercised not to employ the chisel above the level of this structure unless it be the intention of the oper-

ator to enter the middle fossa of the skull and expose the dura of the temporosphenoidal lobe for exploratory or other purposes. The above deductions include most of those which are suggested by such structural peculiarities as may with propriety be considered to lie within normal anatomical limits, and any further conclusions which can be derived from inspection must have their origin in pathological changes of the cortex, of which the first to suggest themselves are *alterations in color*. The surface may present a brilliant glistening ivory whiteness indicative of thick and dense cortical bone, beneath which proliferative osteitis has long been in progress with resulting osteo-sclerosis; again, the surface may be of a distinctly bluish hue as the result of necrosis of the underlying diploic structures and the presence in the subcortical cells of dark granulations accumulated beneath and almost ready to burst through the very thin bony covering; this appearance is often manifested in severe attacks of acute purulent mastoiditis, but the bone is seldom uniformly discolored, there being one or more circumscribed bluish areas significant of the location of greatest inflammatory intensity and earliest molecular death. Numerous minute dark blue points in the cortex will be frequently observed upon close scrutiny, especially in the vicinity of the antrum, affording a somewhat cribriform appearance to the locality, a manifestation which may be characterized as a "shaven beard" appearance; the interpretation of this feature is simple: the blue points are thrombi in the nutrient venous capillaries perforating the outer wall of the antrum and their presence betokens a speedy death of the tissue thus deprived of nourishment. A step further in the process and the bone assumes a brownish black or even a decided black color: necrosis has then been fully established, and destruction of bone in larger or smaller masses, which soon become detached (sequestra), ensues.

The whole apophysis should be closely scrutinized in order

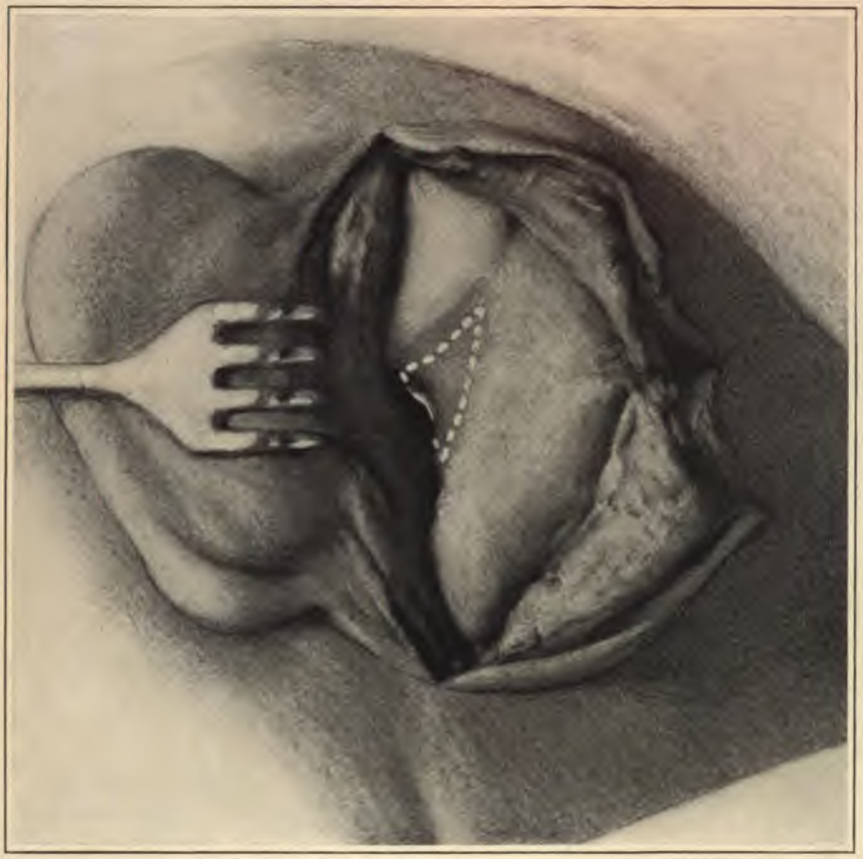
## EXPLANATORY NOTE TO PLATE V.




This plate shows the exposure of the entire mastoid apophysis, with a portion of the squama and temporal ridge; the lower half of the process, which, together with the tip, was concealed and protected by the tendons of the sterno-mastoid and splenius capitis in Plate IV, is here divested of its fibrous covering and prominently displayed, exhibiting an unusually long and sharply acuminated bone.

In striking contrast to the tense anterior flap, which must be supported mechanically throughout the operation, are seen the upper and lower halves (1) (2) of the posterior flap, which, folded upon themselves, maintain their sagging position without instrumental or other aid. The preservation of all the detached periosteum (3—4) may be readily appreciated; the periosteum lining the upper portion of the flap (3) being smooth and free from indentations, indicating its loose attachment to that portion of the cortex from which it has been elevated, in contrast with the wrinkled and pitted appearance of the periosteum lining the lower part of the flap (4), which with its penetrating tendons has been forcibly torn from the bone. The landmarks defining the situation of the supramastoid triangle are indicated by dotted lines (5); included within this area will be found upon the cortex the supramastoid spine and fossa, and immediately beneath the same, at a depth varying between 10 and 20 m.m., the mastoid antrum. (6) Occipital groove. (7) Supramastoid spine.

PLATE No. 5.



that any perforations, inequalities, or irregularities of the surface may be recognized and their importance duly determined.

It need not be inferred that every deviation from the normal symmetry of the bone will be replete with surgical significance, for undoubtedly many noticeable deficiencies are simply anomalies of development, the result of nature's vagaries, and of no particular consequence; when, however, we encounter cortical perforations of various sizes and shapes the conclusion is simple and direct—they are outlets established by nature for the relief of pressure; if they are located over the situation of the antrum we may have to contend with a purulent inflammation of that cavity alone, but more probably with an involvement of the entire process, which surmise can be converted into a certainty only when the bone is opened and thoroughly explored.

When cortical perforations are discovered in the medial plate beneath the tip (Bezold) or posteriorly over the region of the sigmoid groove the inference is clear that a suppurative inflammation has extended from its source in the tympanum through and beyond the antrum a great distance into the cellular structures of the mastoid process, where its erosive action has produced the perforations just enumerated.

The cortical openings assume manifold and various irregularities of outline and proportion, sometimes single and again multiple—in the one instance isolated and in the next coalesced (see PLATE VI)—here a hole with serrated or stellate borders and there a sharply defined circular erosion within the orifice of which sequestra of divers and sundry shapes and sizes appear, comprehending such as are merely fragmentary remains of cortical bone as well as those which are large enough to close the aperture tightly, admitting only of the protrusion upon the surface of granulations from the inflamed bone beneath.

A fenestrated or cribriform appearance may occasionally

be noted in the vicinity of the suprameatal triangle, the minute capillary perforations of which have served as channels for the filtration of sufficient pus to cause detachment of the periosteum and to produce a subperiosteal abscess of greater or smaller size.

Occasionally the surface of the mastoid will show a dimple or umbilication the centre of which is filled with very dense white bone the result of productive osteitis instituted during the course of a former suppurative mastoiditis which had progressed to the stage of cortical perforation with subsequent recovery without operation but with resulting osteosclerosis. Should such a process be again attacked by a purulent inflammation the danger to the life of the patient would be greatly exaggerated because the outer table has now become impenetrable to pus (iron-clad, as it were), which septic product is hence so much the more liable to seek for itself an avenue of exit elsewhere, in pursuit of which means of escape the middle or posterior cranial fossa offers the most convenient and accessible outlet and infection of the contents of these cavities supervenes unless prompt surgical relief is afforded.

Roughness of the cortex, without appreciable discoloration or softening, is very common, particularly if it has been subjected to the erosive action of a subperiosteal accumulation of pus, or even in the absence of pus, when the outer table of the process is very thin and the inflammation severe, a localized periostitis ensues with corresponding superficial erosion.

Notches, ridges, depressions and the like unless sufficiently pronounced in character to materially alter the contour of the mastoid process are not entitled to serious consideration and as far as their surgical significance is concerned may be disregarded.

The exact importance attributable to certain of the deductions which have been drawn from structural peculiarities and anatomical characteristics of the mastoid bone, and which in

the foregoing paragraphs have been emphasized as valuable guides when correctly interpreted, is in many instances problematical. A similar depreciation might, however, with equal fairness be employed to belittle the value of any group of anatomical landmarks elsewhere about the body, for while the import of some constant phenomena is undisputed that of others is largely conjectural; in any event the observations above recorded are wise precautionary measures and neglect of them may expose to needless risk some patient whose life careful appreciation of the same would protect and safeguard.

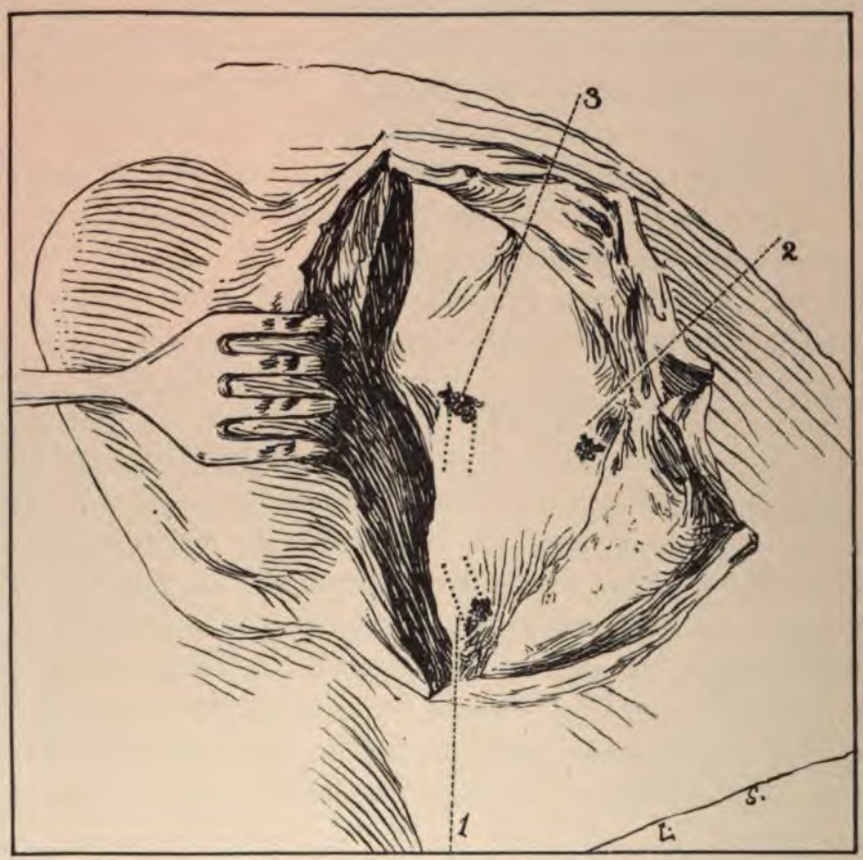
## FAULTS OF TECHNIQUE.

The most conspicuous fault of the beginner's technique in elevating the periosteum and reflecting the flaps is a tendency unnecessarily to mutilate the periosteum. All mutilation may be avoided and the membrane preserved for its properties of nutrition and regeneration if the operator will simply observe the caution of placing the periosteotome firmly upon the bone at the point where the investing nutrient membrane has been divided by the scalpel and carefully pry the periosteum loose from its attachments so that it rolls up before the pressure of the instrument.

With proper care and reasonable skill the periosteum can then be rolled away from the bone in much the same manner as the peel is drawn from a banana.

The instrument which is employed contributes in no small measure to the habit which some operators acquire of forcibly rending and lacerating the periosteum, and could the use of the Langenbeck periosteotome become universal, the preservation of this important structure would be assured, for with the employment of that instrument even the most ruthless operator is restricted in the amount of damage which he can cause. There

## EXPLANATORY NOTE TO PLATE VI.




This plate shows a left mastoid process on which are diagrammatically indicated three cortical perforations in situations arbitrarily selected, but which correspond to the locations of similar spontaneous openings in the outer table as encountered in suppurative mastoiditis. Perforations may occur in any one of a thousand different situations upon the mastoid cortex, and may be single or multiple. The author has chosen for purposes of demonstration a perforation at the tip, the point of selection for spontaneous solution of integrity in the adult, owing to the thin walls of the oftentimes very large tip cell; this opening should not be confounded with perforation of the medial plate (Bezold), which occurs in the occipital groove beneath the tip.

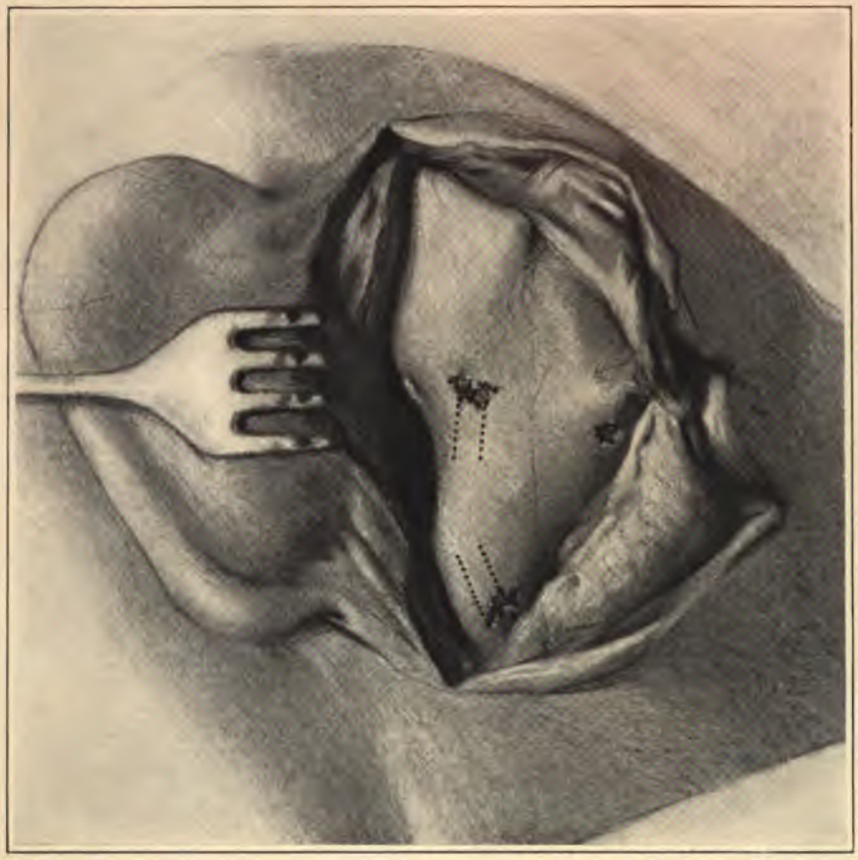
(2) A perforation over the situation of the sigmoid sinus, which, when found, usually signifies communication with the interior of the skull through the sigmoid groove.

(3) A perforation within the boundaries of the suprameatal triangle, the point of selection for evacuation of pus through the thin external wall of the antrum in childhood and early youth.

The dotted lines at 1 and 3 indicate the direction in which the gouge should be employed when the operator elects to take advantage of the opening which nature has afforded, to facilitate his procedure.

No dotted lines are plotted at (2) because when a single perforation exists in such a situation the operation will be more safely and expeditiously performed by disregarding the spontaneous opening and attacking the bone with the INITIAL GROOVE, in the suprameatal triangle, as indicated upon Plate VIII.

PLATE No. 6.



are few faults in the technique of the mastoid operation which are so uniformly observed as mutilation of the periosteum, and there are few errors which can be so easily corrected.

A not infrequent error of technique is attributable to lack of judgment upon the part of the assistant who holds the retractor. He should be warned against exerting unnecessary traction upon the anterior flap and auricle, lest by the employment of undue force he cause separation of the fibro-cartilaginous meatus from the bony canal. Such an accident is to be deplored, inasmuch as it results, in the majority of instances, in a more or less pronounced atresia of the meatus.

## CHAPTER VIII.

# THE CONSTRUCTION OF THE INITIAL GROOVE-SHAPED OPENING IN THE MASTOID CORTEX.

THE CONSTRUCTION OF THE INITIAL GROOVE-SHAPED OPENING OF THE MASTOID CORTEX CHARACTERIZES THE THIRD STEP OF THE OPERATION.

The primary opening in the bone is to be made with a medium width gouge and assumes the shape of a groove, the situation of which is along the extreme anterior border of the mastoid process skirting the brim of the bony meatus. **PLATE VIII.**

The groove begins in the suprameatal triangle at the centre of the suprameatal spine and extends thence downward to the tip, penetrating the bone only sufficiently deeply to expose the diploic or pneumatic structures immediately beneath the outer table. With a narrow oblong curette the spongy bone is scooped out within the limits of the groove until the edges of the cortical bone which border the opening posteriorly are slightly undermined and overhang the cavity thus created.

In those mastoid processes which, as the result of proliferative osteitis, have undergone osteo-sclerosis, the deep

**channeling of the bone cannot be readily accomplished with a curette, in which event a narrow gouge must be relied upon.**

**When a cortical perforation already exists, as in cases of subperiosteal abscess, the operator may avail himself of the opening provided by nature and proceed thence with the removal of the diseased process. PLATE VI.**

The determination of the precise point upon the mastoid cortex at which the process may be most advantageously opened should be attended with no extraordinary difficulty. The conformation of the bone is such and the course of those structures which traverse its interior and indent its inner table is so thoroughly understood as to make the selection of the cortical area which is first to be attacked an exceedingly simple proposition.

The point of selection for the opening of the mastoid cortex lies within the supramcatal triangle, the boundaries of which so denominated space are clearly delineated in PLATE V.

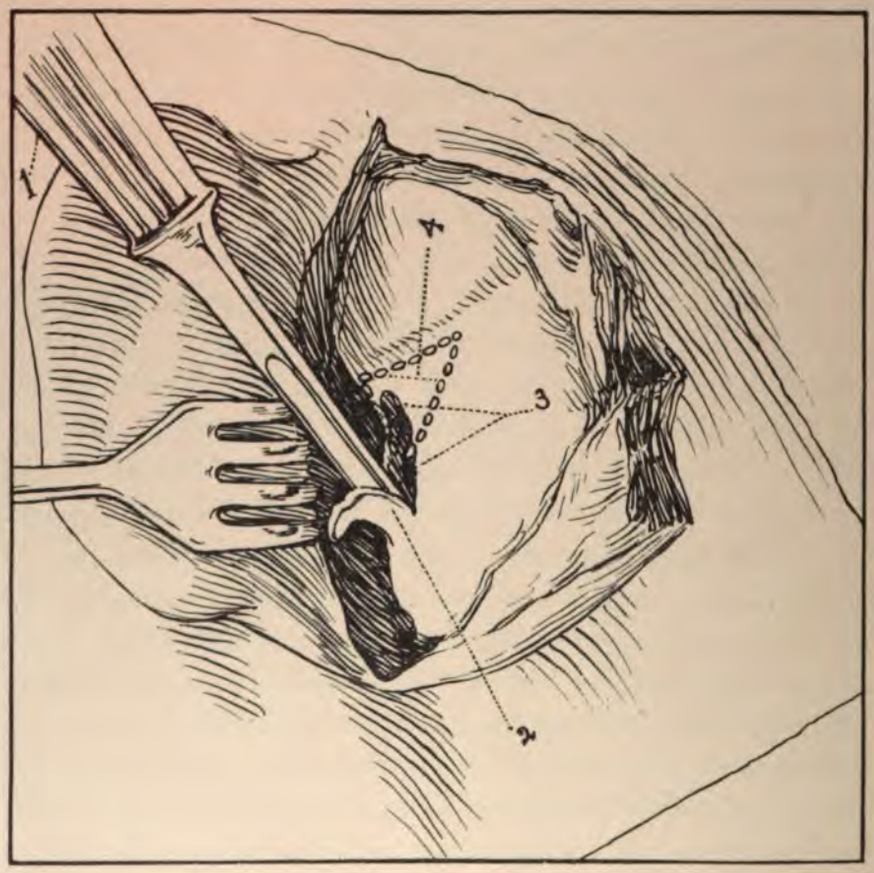
It is the practice of the writer to make as the initial opening in the cortex, a long and narrow groove, beginning at the centre of the supramcatal spine (which, if present, is perched upon the brim of the bony meatus in its superior posterior segment PLATE V, No. 7), or at a point corresponding to its situation in the supramcatal triangle and extending thence downward, closely skirting the brim of the bony meatus and the anterior border of the mastoid process as far as the extreme tip, PLATE VIII. This groove is made with a medium width gouge, the penetration of which should be carefully graduated so that only the cortex and the most superficial sub-cortical cells are included in the layer of bone thus removed.

The cardinal maxim of every operator upon the mastoid should be—*Keep the posterior margin of the bony meatus always in view and hug it tight* until the gradual removal of the contiguous diploic

bone admits of determining with positiveness the course and situation of those salient structures which are distinctive of this region and the preservation of which from injury is so essential to the successful prosecution of the operation. With a definite knowledge of the location of the sigmoid sinus and facial nerve the surgeon is justified in proceeding with increased confidence and celerity, as the wounding of the external semicircular canal, the only remaining structure of importance in that portion of the mastoid, would, save under most exceptional circumstances, signify an absolutely culpable disregard or an equally reprehensible ignorance of well established anatomical landmarks and surgical guides. It cannot be offered as a valid excuse for the wounding of the sinus, for instance, that the operator drove the chisel or thrust the curette forcibly into a part of the bone in which, under ordinary circumstances, this structure should never trespass; nor can it be urged in extenuation of similarly inflicted damage to the facial nerve that "it was lying out of its course." It is the province of the skilful doctor to anticipate such anomalous distribution or arrangement and by excessive caution to escape the snares and pitfalls which beset the path and compass the confusion of the unwary. It need not, however, be anticipated that superlative skill, even when attended with saintly patience and unremitting care, will prove an unerring guide to invariable success. The exercise of these virtues will unquestionably dispose to minimize the ever present dangers and difficulties of the operation, but no endowment short of preternatural surgical intuition would enable a man to avoid with infallible judgment every complication which the distorted or irregularly developed bone at times presents.

It has been said of the sigmoid sinus that *its course lies everywhere throughout the mastoid bone*, and when the multitudinous ramifications of the sigmoid groove are con-

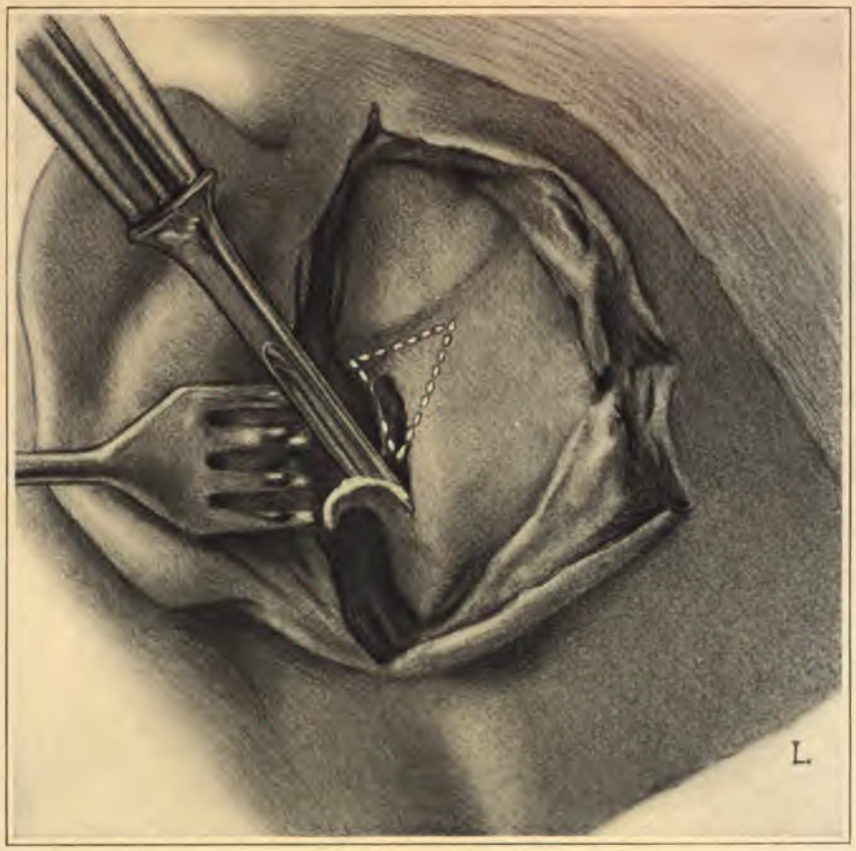
## EXPLANATORY NOTE TO PLATE VII.




This plate shows the same position of the flaps and a similar exposure of the bone as in Plate VI. The manner of opening the mastoid cortex with the gouge is here demonstrated with the instrument in position.

The engraving shows clearly the thin shaving (2) of cortical bone raised by the gouge (1) and the upper portion of the resulting shallow groove (3) in the mastoid process; (4) suprameatal spine and triangle.

PLATE No. 7.



sidered, that statement can scarcely be characterized as unduly extravagant. It was chiefly with the intention of insuring safety to this structure that the groove along the anterior border of the bone was adopted for the primary opening, and for the following reason: It is by no means uncommon upon examining skulls to find the sigmoid groove dipping very deeply into the cranial wall, especially upon the right side, oftentimes indeed encroaching closely upon the posterior wall of the bony meatus (PLATE E) and in the same instance lying so superficially that only a very thin layer of cortex and subcortical cells separates it from the periosteum.

In the experience of the writer the knee of the sinus has frequently been encountered within the boundaries of the suprameatal triangle, and in a few instances so situated in front of the antrum as to necessitate cutting away the roof and the superior posterior segment of the bony canal a considerable distance within the orifice, to obtain admission to the antral cavity without injury to the sinus. Dr. Knapp once exhibited to the author a temporal bone in which the sigmoid groove lay in front of the antrum, with the knee, as nearly as can now be recollected, vertically beneath the suprameatal spine and separated from the outer table by the thinnest possible layer of cortical bone, not thicker than heavy wrapping paper. No argument is required to demonstrate clearly that the sinus, when occupying such an anomalous situation, must infallibly be wounded in the performance of the mastoid operation, if the bone is opened in the manner commonly practiced. That the danger of such accident may be as far as possible diminished, the groove along the anterior border of the bone is advocated.

There is, of course, great disparity in the thickness of different parts of the skull, some portions being very thick and other portions very thin. For purposes of operative procedure,

however, no one part of the cranial wall should be regarded as thicker than the remainder, which anatomical incongruity may be reconciled and epitomized as follows: ***just as a chain is no stronger than its weakest link, so the skull is nowhere thicker than its thinnest portion.*** This surgical precept if firmly fixed in the minds of all operators would materially modify the liability to accident. The mastoid cortex should always be opened with the same deliberation and caution as would characterize a similar procedure upon the thin squamous plate, and only after determining with positiveness the situation of the sinus, may the operator proceed with greater freedom, but with watchfulness still undiminished.

The groove along the anterior border of the process is no absolute guarantee of protection for the vital structures contained within it, nevertheless the groove contributes an element of safety to the operation which is wanting in other methods at present proposed; indeed, with the exception of Broca and Maubrac, Bacon in his "Manual of Otology," 1900, Dench in his admirable monograph upon the mastoid operation in the New York Eye and Ear Infirmary Reports, 1899, and Allen (The Mastoid Operation, 1892), all authors have dismissed the technique of the mastoid operation with but meagre attention to detail, and regarding the original opening in the bone have advised merely that it be made in the vicinity of the bony meatus. Such astounding latitude, however, does many a doctor permit himself in his construction of the idea conveyed by the word *vicinity* that any point upon the corresponding side of the skull situated nearer the auditory canal than the occipital protuberance might be accepted as being near the meatus. Hence occur experiences similar to that reported by Dr. Buck (who was requested to re-operate upon a case the perplexities of which a brother practitioner had failed to unravel and the urgency of whose symptoms

rendered imperative speedy relief), who found upon opening the unhealed wound and retracting the flaps, that the entire mastoid process was still intact, but that a large opening had been made in the occipital bone, through which presented the healthy dura of the cerebellum. Now it is quite possible or even probable that such experiences will continue to confront otologists in years to come, notwithstanding the crusade of enlightenment which is being pursued, but it is in the hope of correcting just such mistakes that the writer is devoting careful consideration to the most insignificant detail in the technique of the mastoid operation, for while to the experienced operator a mere suggestion will often suffice to furnish the needful guidance, to the beginner lacking both confidence and experience instruction cannot be too explicit nor demonstration too graphic.

*When upon the completion of the initial groove in the bone neither pus nor other fluid escapes*, it is well before proceeding further with the removal of the cortex to deepen the groove by using a narrow, oblong curette or Volkmann's spoon, moderately sharp upon the edge, with which the diploic structure of the bone, if softened by caries, is easily scraped away. The resistance of the same tissue where not undergoing carious disintegration may be sufficient to require the employment of a sharper curette and increased expenditure of force; further, when upon occasion the bone, as the result of chronic mastoiditis, has undergone proliferative osteitis and become sclerosed or eburnated, its density will successfully resist all attacks of the curette, and a narrow gouge or chisel must provide the requisite means for deepening the superficial primary channel. This step may serve the twofold purpose of disclosing the presence of a collection of pus contained beneath the deeper layers of bone as well as happily of revealing the situation and direction of the sigmoid groove, if by any chance that structure occupies a position suffi-

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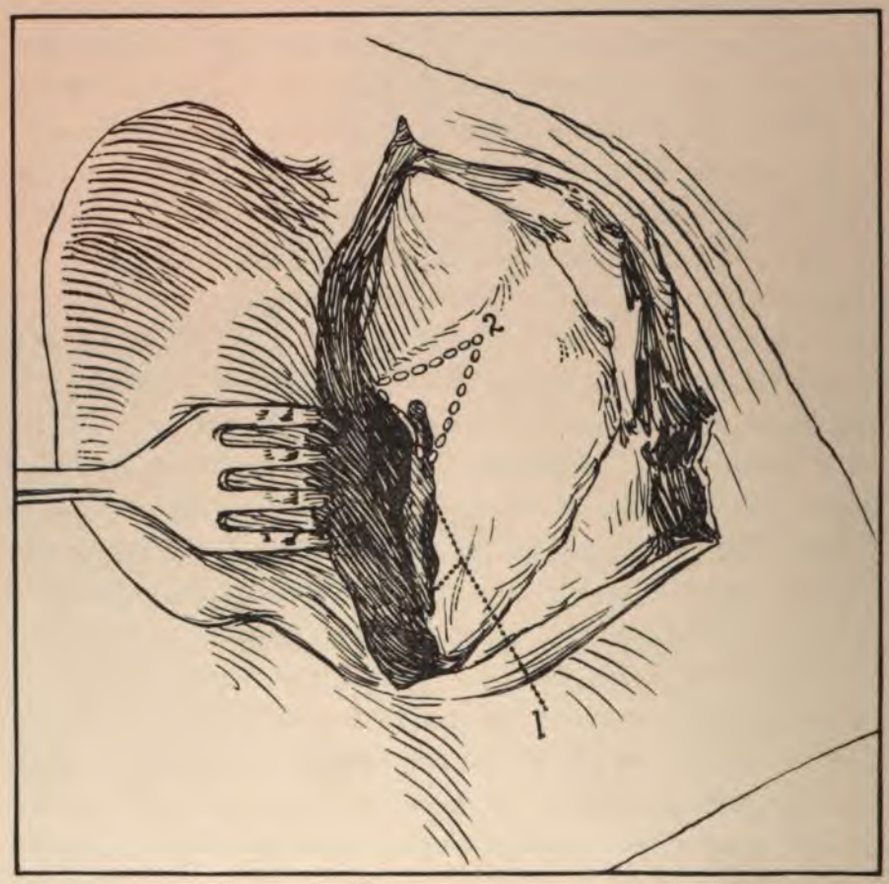
## EXPLANATORY NOTE TO PLATE VIII.

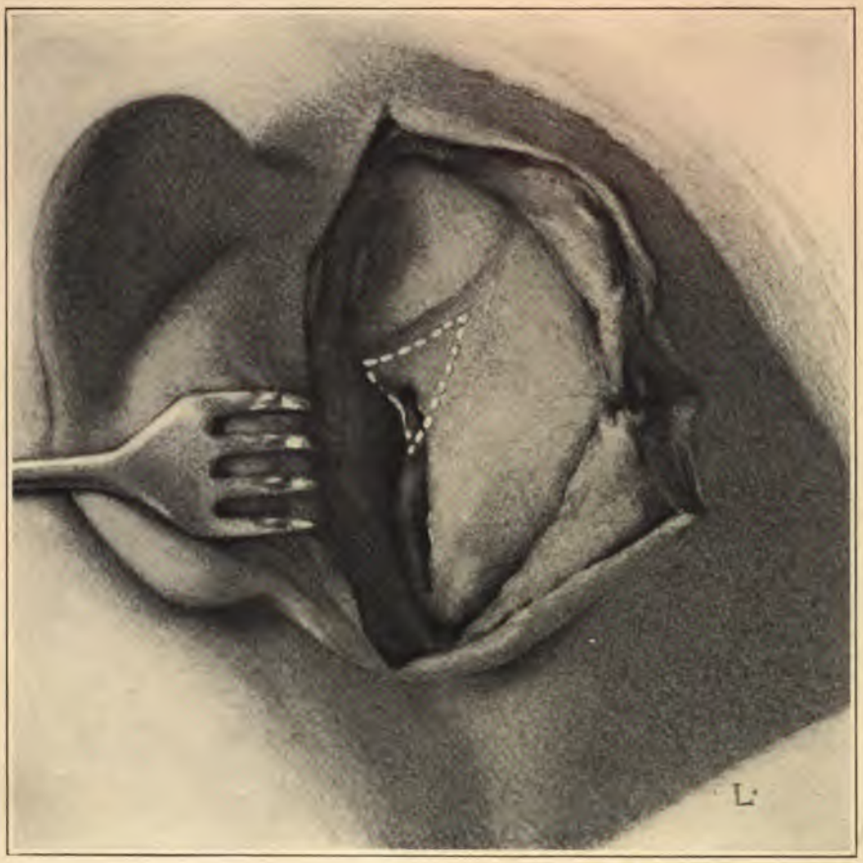



This plate shows the same position of the flaps and a similar exposure of the bone as in Plate VII, and in addition thereto demonstrates the completion of the first distinctive step in the removal of the mastoid cortex, called the INITIAL GROOVE (1).

The groove (1), made with a medium width gouge, begins at the suprameatal spine above and extends thence downward to the mastoid tip along the anterior border of the process, close to the posterior margin of the bony meatus, and penetrates the bone to a depth only sufficient to expose the most superficial of the subcortical cells.

The relations of the initial groove (1) with the suprameatal triangle (2) are clearly indicated.

PLATE No. 8.



ciently far forward to be menaced in the subsequent removal of the cortex.

*In the event of pus escaping from the primary opening in the bone* a probe should be at once gently introduced and made to define the limits of the cavity thus exposed. Such cavities may be very contracted, representing simply the coalescence of a few pneumatic spaces, in which case the excursion of the probe will be restricted; or they may be spacious chambers, which would imply extensive destruction of the process, and the probe should indicate the same by its unimpeded progress in all directions corresponding to the dimensions of the mastoid bone.

The mission of the curette is greatly simplified in purulent mastoiditis, where, under the destructive action of pus, solution of the intercellular osseous basement structure has progressed to a considerable extent. So friable in consistency and of such crumbling texture does the osseous tissue become under these destructive influences, that great care must be observed lest the curette, by the exercise of undue force, be transformed from an eminently safe into an equally dangerous implement. The careless manner in which, with an appalling disregard for consequences, the curette is often employed while its blade is buried from sight within the softened walls of a cavity, renders a word of warning at this moment perhaps not inopportune. One should always feel apprehensive when using any instrument for the purpose of removing tissue within a space which cannot be inspected, particularly if important vascular and nervous structures lie within close proximity. Under such circumstances it is simply the part of propriety to display assiduous care, hence the exhibition of indifference which we sometimes witness in the "brilliant operator," so far from being worthy of our emulation, is to be positively condemned.

*When pus escapes from the bone either upon the first stroke*

*of the chisel or with the subsequent enlargement of the opening, its manner of coming to the surface will oftentimes supply to the observing operator a valuable hint of the conditions within the bone;* for example, should it ooze slowly out in small quantity from the mastoid, the likelihood is that disintegration of the spongy tissues in the interior has not progressed to great length; should it *well up rapidly and in large quantity without pulsation*, there is strong probability of extensive purulent disintegration within a spacious cavity, the bony walls of which, however, are still intact; but where, in addition to flowing rapidly and copiously from the bone, *the stream of pus pulsates actively or is expelled in little jets*, the evidence is conclusive, not only that purulent liquefaction of a large portion of the diploic structure of the mastoid has supervened, but also that destruction of the inner table of the skull has ensued, leaving the meninges exposed to the erosive action of the infective elements contained in the pus—the condition is, in other words, what is known as *epidural abscess or circumscribed pachymeningitis externa*, and the pulsation of the discharge as it pours forth is transmitted from the brain, with the coverings of which, over a greater or smaller area, it is already in direct contact.

When, as occasionally happens in young children and also with great infrequency in adults, it can be plainly seen that pus within the mastoid is situated so near the surface as to require only gentle curetting to establish communication with the abscess cavity, or when a cortical perforation already exists, as in cases of subperiosteal abscess, the operator may instead of making the initial groove avail himself of the opening thus provided by nature for the safety of the patient, and with curette or rongeur, whichever under the circumstances prove most convenient and serviceable, carefully remove the contiguous osseous structures in the direction and vicinity of the bony meatus and down-

ward along the anterior border of the process, toward the tip, keeping as nearly as possible within the same boundaries as those which govern the situation of the *initial groove.*

This variation in the technique of the operation may be practiced to decided advantage only when the perforation is situated nearer the anterior than the posterior border of the mastoid process or when the opening is very large. Under other circumstances it will be found preferable to adhere to the rules formulated for guidance in making the *initial groove.*

The further removal of the bone will thereafter follow the lines which characterize the operation when performed upon an inviolate cortex.

In infants and young children up to eight years of age it is the practice of the writer to make the initial groove and in fact the entire opening in the mastoid bone with a curette. The bones of the skull at this early age are very soft, and as the cortex is thin, but little force is required to remove it; the more especially since the bone is now softened and in parts disintegrated by a suppurative process.

The writer considers it important whenever possible to eliminate the chisel from the mastoid operation, for the simple reason that of those accidents which have come to his notice in mastoid surgery by far the greater proportion were attributable to some faulty manipulation with either the chisel or gouge. Whatever may be the risks of injury to which the use of the chisel necessarily exposes adults, such danger must perforce be exaggerated in children to a considerable degree, for the reason that the same number of vulnerable structures are here concentrated within much more contracted boundaries, while the soft and crumbling character of the bone in infants opposes such feeble resistance to removal that the use of chisel and mallet is not only quite superfluous but entirely unwarranted.

## FAULTS OF TECHNIQUE.

The faults of technique which are commonly observed in opening the bone, other than those due to hesitation and anxiety because of inexperience or nervousness, are, first, those which are attributable to the employment of chisels or gouges of insufficient length to admit of their being firmly grasped; and, second, a disposition to drive the gouge *too deeply into the bone* and to begin the opening of the cortex in a situation *too far removed posteriorly from the margin of the bony meatus.*

It is exceedingly difficult to hold the short Schwartze gouge in the hand in such manner as to admit of removing a long shaving of cortical bone; the instrument must be held in the fingertips, which cannot of course guide it with the precision which is imparted by the firm grasp of the full hand. This difficulty may be obviated by employing longer gouges, such as the author himself has devised, and which are provided with a serviceable and convenient handle or grip, much after the style of the carpenter's tool (see PLATE XVIII). Beginners are also disposed to select narrow gouges, whereas the widest gouge that can be conveniently employed is the most serviceable and safe, since it is less likely to bury its point deeply in the bone and inflict damage upon any of the important structures which traverse its interior.

## CHAPTER IX.

# THE CONSTRUCTION OF SUCCESSIVE CORTICAL GROOVES PARALLEL WITH THE INITIAL GROOVE.

THE CONSTRUCTION OF SUCCESSIVE CORTICAL GROOVES PARALLEL WITH THE INITIAL GROOVE CHARACTERIZES THE FOURTH STEP OF THE OPERATION.

**With a gouge or chisel of medium width successive narrow grooves of the cortex are hollowed out parallel with the primary opening in the bone and penetrating only sufficiently deeply to lay bare the most superficial of the underlying diploetic structures. These grooves extend from the temporal ridge downward to the mastoid tip (see PLATE IX). The softened walls of the pneumatic spaces disclosed in this manner are removed by curetting, until the width and depth of the cavity thus produced are sufficient to admit of the introduction of the blades of a rongeur. When, owing to osteo-sclerosis, the diploic structures of the process have acquired a density almost uniform with the hardness of the cortex, this channeling must be performed with gouges or with a rotary bur, the curette being under such circumstances inefficient.**

The deepening of the initial groove in the mastoid process

until the pneumatic cells in the body of the bone are opened to a depth of one-third of an inch (8 m.m.) or thereabouts will demonstrate the presence or absence of the sinus in a dangerous situation.

*When the sigmoid sinus is exposed by the curetting necessary for deepening the groove, how may it be recognized and how will its presence influence the subsequent mastoid procedure?*

The recognition of the sinus will be easy or difficult according as its wall is normal in appearance or invested with plastic lymph and granulations.

It is highly important that every doctor before attempting the mastoid operation should familiarize himself with the appearance of the healthy dura in order that he may recognize it immediately upon exposure and thereby avoid doing violence to the meninges by protracted exploratory probing, which proper preliminary experience should render quite unnecessary.

When in any portion of the deepened initial groove there appears a soft bluish looking structure very fluctuant to palpation and perhaps pulsating demonstrably, which upon gentle pressure of a probe yields readily *but does not bleed*, it is the dura; and if it is situated below the level of the superior border of the bony meatus is most likely the parietal wall of the sigmoid sinus in the descending part of its course—in any event, a structure presenting the above mentioned physical characteristics should be so regarded until further exposure either confirms or disproves it.

When the sinus wall is invested with fibrin and granulations, the difficulties of diagnosis are greatly exaggerated, for while granulations may spring from the irritated dura, they are liable also to grow with equal luxuriance from the disorganized spongy bone within the interior of the mastoid, so that the presence of granulations in the primary opening is not necessarily significant

of the proximity of any intracranial structure; nevertheless in the presence of danger it is the part of prudence to be ever on the alert, and until the operator can feel assured that he is not dealing with the granulating sinus wall, every such mass of granulation should be treated with the same distinguished consideration which is accorded to a similar outgrowth concerning whose connection with the wall of the great vein there is no doubt.

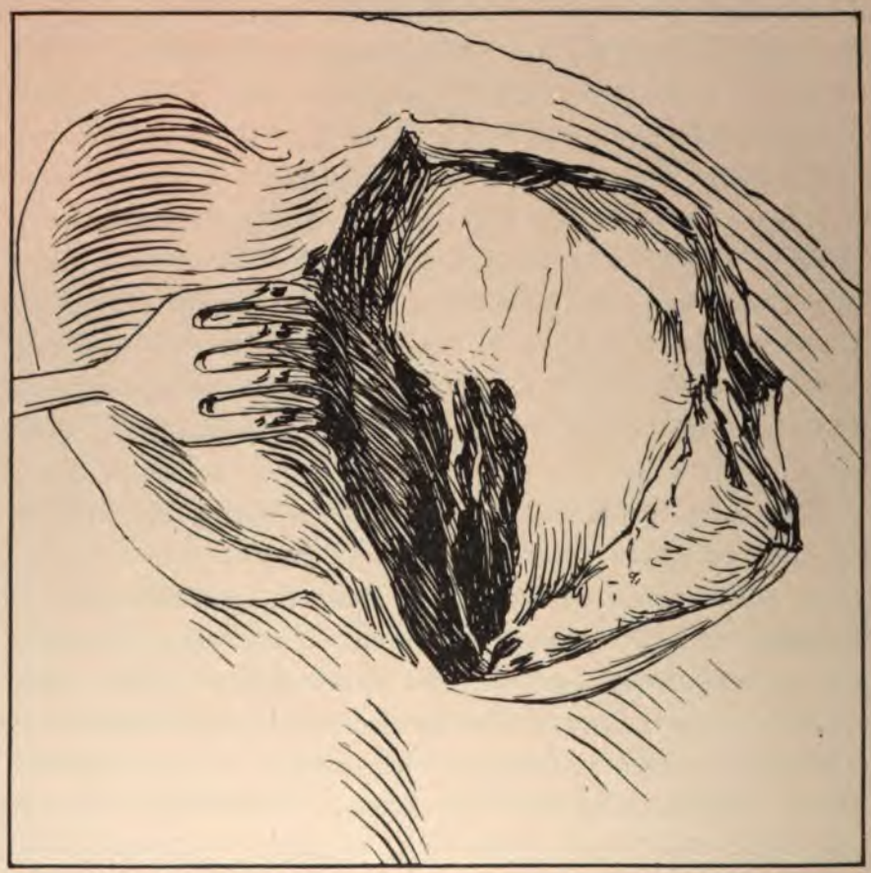
Usually the probe will enable an operator to decide promptly as to whether the granulations simply surround a necrotic focus of bone or are protruding into the cavity in the mastoid through an opening in the inner table of the skull. If an opening in the bone exists which communicates with the cranial cavity, the probe will convey intelligence of its presence by absence of resistance in that particular direction, while if the cranial walls are intact the probe will encounter the firm, uniform resistance of bone in every direction.

*How is the subsequent conduct of the operation influenced by the exposure of the sinus in the initial groove?*

Such an anomalous situation of the vein constitutes an embarrassing though fortunately infrequent complication; it serves as a warning that the middle third of the mastoid process is occupied by a refractory tenant which is least mischievous when undisturbed, hence it behooves the operator to avoid further encounter by pursuing some other route, less direct, but also less hazardous. He finds it expedient to prosecute his investigations in the upper and lower thirds of the process respectively, as if such portions of the bone were quite independent of the middle or connecting third and of one another as well.

Such a procedure restricts surgical manipulation to a very contracted field and necessitates a careful removal of the mastoid cortex and underlying osseous structures immediately adjoining (and to some extent including) the superior posterior

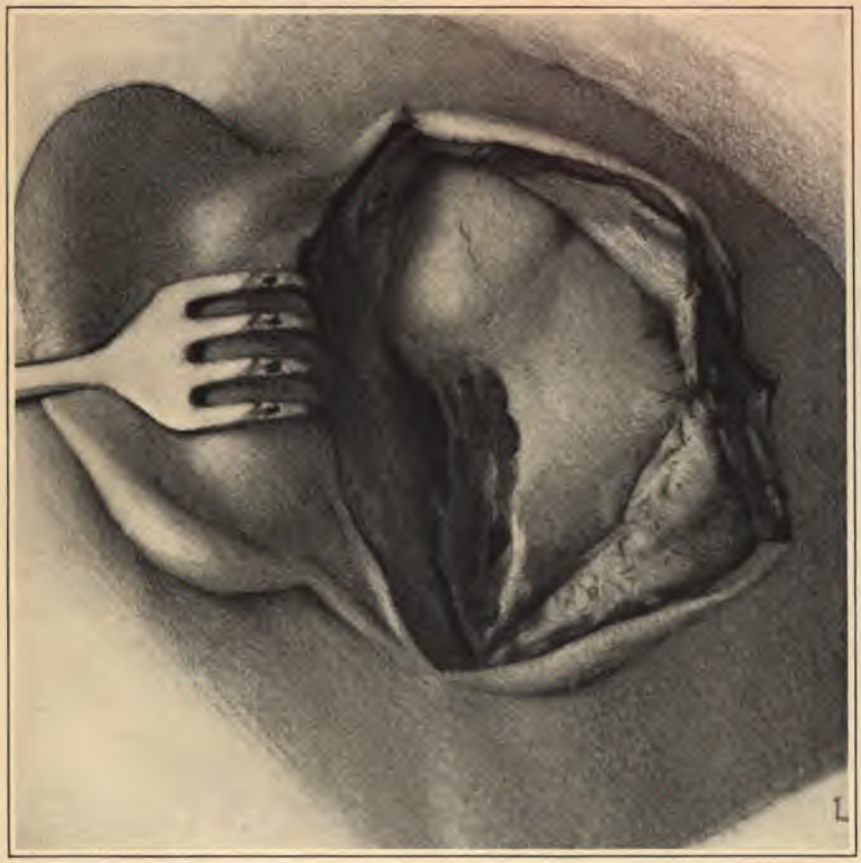
## EXPLANATORY NOTE TO PLATE IX.



This plate demonstrates the second distinctive step in opening the mastoid cortex, namely, the construction of additional grooves parallel with and posterior to the INITIAL GROOVE. (See Plate VIII.)

The pneumatic character of this process is plainly exhibited, numerous spaces appearing in the open bone cavity.

PLATE No. 9.



quadrant of the bony meatus and the inferior border of the temporal ridge, until communication with the antrum is established, which cavity must be enlarged by curetting as far as the encroachments of the sinus will permit. The removal of the tip will then follow and can be most safely accomplished by attacking it at the extreme apex with a broad-bladed rongeur, gradually gnawing away the process until all the pneumatic and diploic cells containing pus have been opened.

To a beginner in mastoid surgery an experience such as has just been recounted would be unquestionably very disconcerting; however, he may find comfort in the assurance that fate is seldom so ironical as to impose upon the nerves of a novice a trial so severe.

When the deepening of the *initial groove* has demonstrated the fact that the course of the sinus does not lie close to the bony meatus, the object of the ensuing or fourth step is to take away such additional portion of the cortex as will by its removal expose a sufficient extent of cellular tissue to afford after its extirpation ample space for the introduction of the blades of the rongeur beneath the surrounding and overhanging outer table.

A gouge or chisel of moderate width will serve the purpose intended, and as in the case of the first groove cut in the cortex, so with the succeeding parallel grooves cut along its posterior margin, the depth to which the gouge enters the bone must be so carefully graduated that only the most superficial subcortical cells are included in the shaving of bone displaced by the chisel. The grooves, two or more in number, according to width, should begin the same distance below the temporal ridge as their fellow already described, and extend thence downward parallel with the original opening in the mastoid, to the tip. These combined grooves will adequately serve their purpose when they produce an opening $\frac{1}{3}$ to $\frac{1}{2}$ inch (8 to 12 m.m.) in width in the aggregate.

With the completion of these grooves the use of the chisel can generally be dispensed with and the remainder of the operation performed with various curettes, both sharp and dull, supplemented by rongeurs of different sizes. When, however, increased density of the bone renders progress by such methods undesirably slow, the operator must again have recourse to the gouge.

In the hands of a skilful operator the exigencies of the situation seldom require the use of the chisels or gouges, save for an occasional stroke, after the construction of the parallel grooves; hence the objection urged against the gouge by the advocates of the bur, namely, that it inflicts undue shock and violence upon the intracranial structures during its employment, is, when applied to the classical operation, a very insubstantial one, for in most instances the gouge will have accomplished all that is required of it within five minutes or even less time, whereas the operator who places his reliance upon the bur must be content with much slower progress.

The introduction of the rongeur, with its various modifications of shape and size, has revolutionized our technique in America and has both simplified and expedited the procedure to a remarkable extent. The value of the rongeur in the modern mastoid operation cannot be overestimated, for not only has it greatly reduced the time required in removing the necessary bone, but it has in equal degree diminished the dangers of injury to important vascular and nervous structures.

But a few years since the chisel, gouge, and curette were the sole dependence of the operator in this field, and at that time the advocates of the employment of the bur had good reason to deprecate the continued shock to the contents of the skull administered by protracted use of the mallet and chisel. The justice of this hostile attitude was recognized in this country and a remedy invoked, *which should not only diminish shock*,

*as the bur undoubtedly did, but which should, in addition, materially reduce the duration of the operation, which the bur distinctly did not do.*

The solution of the problem has been found in the various rongeurs which we now employ and which are absolutely indispensable to the prosecution of a satisfactory and thorough operation. Numerous admirable devices are exploited by the instrument-makers, and doubtless each possesses its special merit. There are, however, several which, in the judgment of the writer, are to be especially commended for their efficiency, the absence of any of which from the armamentarium entails a positive embarrassment upon the operator. The rongeurs upon which the author relies during his operations and which he has come to regard as indispensable to finished operating are those devised by Mathews, Adams, McKernon, Jansen, Dench, and Pyle. There are doubtless other efficient instruments to which other operators would perhaps award the preference, but the above mentioned patterns with their different sizes leave little to be desired, either as regards convenience of manipulation or thoroughness of execution.

## FAULTS OF TECHNIQUE.

The fault most commonly observed in making the parallel grooves in the bone for the purpose of exposing sufficiently the cellular structures of the mastoid is a disposition to begin too low down upon the apophysis, that is to say, too far beneath the temporal ridge, and to drive the chisel too deeply into the cellular structures; to a depth, in fact, which is beyond the margin of safety.

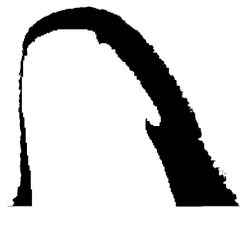
The operator should never forget that the sigmoid groove travels a very uncertain course, and that its vagaries in this respect are past accounting for; he must be continually on the

watch for the sinus, which not infrequently is situated immediately beneath a thin, dense cortex, in a position to be easily wounded; when such an injury is inflicted upon the sinus very early in the course of the operation and before that great vein is sufficiently exposed to admit of readily controlling the bleeding, the accident seriously complicates the procedure and assumes proportions of gravity which the same extent of damage inflicted after the process had been well opened would not signify.

A warning against the inconsiderate and reckless use of the chisel in its first few strokes cannot be too often reiterated, for while it is an instrument absolutely essential to the performance of the mastoid operation, it should be dispensed with at the earliest possible moment.

# CHAPTER X.

# THE DETERMINATION OF THE SITUATION AND DIMENSIONS OF THE ANTRUM AND THE EXPOSURE OF THAT CAVITY.



## THE DETERMINATION OF THE SITUATION AND DIMENSIONS OF THE ANTRUM AND THE EXPOSURE OF THAT CAVITY CHARACTERIZES THE FIFTH STEP OF THE OPERATION.

The antrum lies within the area of the suprameatal triangle and in 95 per cent. of all mastoids is to be found at an angle of 45 degrees (or thereabouts) upward and backward from the bony meatus at a depth of from one-half ($\frac{1}{2}''$) to three-quarters ($\frac{3}{4}''$) of an inch beneath the cortex. When not so situated it will be encountered nearer the vertical meridian and further forward, and in certain instances has been found arching over the superior wall of the bony meatus only slightly external to the epitympanic space, with which it communicates by way of the aditus.

When the cavity is opened a probe should be introduced within it and its dimensions determined by means of the excursion of the instrument in various directions. The walls enclosing this space should then be removed until no overhanging borders remain and the antrum is thereby converted from a deep recess into a shallow excavation.



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The particular moment in the course of the mastoid operation when the antrum may most advantageously be opened is perhaps a debatable question, and the writer has observed that operators in proportion with their inexperience and want of confidence exhibit a feverish anxiety to locate that cavity at the earliest possible moment. The air of positive triumph which illuminates the countenance of the beginner when in response to his vigorous and insistent prodding the cellular structures in the vicinity of the meatus suddenly crumble and the probe plunges into the antral space, is frequently most amusing and well worth witnessing; while the look of absolute consternation and acute distress which is depicted upon the same visage, when the erring probe, employed with similar indiscriminate force, thrusts its inconsiderate point into the lateral sinus. furnishes a spectacle which would be ludicrous, were it not that the gravity of the patient's situation immediately and effectually dispels all humorous appreciation from the painful attitude in which the novice by his lack of skill and caution has unwittingly placed himself.

The numerous rules and landmarks for determining the situation of the antrum which have from time to time been accepted as satisfactory and scientific were for the most part the direct outcome and result of the attempts of early operators to reach, explore, and evacuate the contents of a deeply situated cavity by means of a most inadequate, unscientific, and dangerous procedure, namely, through the medium of a narrow and deep channel, the course of which through the bone could not be inspected and the instrument for making which was a sharp pointed drill of a character competent to inflict incalculable damage, should occasion offer. The patient who submitted to such an operation was certainly embarked upon a perilous enterprise and it is not surprising, in view of the dangerous char-

acter of the measure and the inadequate protection provided by the faulty method, that numerous rules should have been formulated, designed to insure a safe and certain route of reaching the antrum.

These rules have in greater or less number survived the passing and decay of the procedure of which they were a natural product, and which they were only able to countenance but never to justify, and as a result of such perpetuation, we, who are learning to operate at the present day, imbibe with our early instruction an exaggerated notion of the difficulties and dangers to be encountered in the task of locating a cavity, the situation of which, with occasional rare exceptions, is determined with great ease.

It is doubtless well, by precept and example, to inculcate a wholesome respect for the structural peculiarities of the temporal bone, and it is certainly the part of wisdom, by the display of an excess of caution, to avoid danger, rather than by reckless disregard for consequences to invite disaster.

So far as the teachings of earlier writers conform to modern surgical methods, we are willing and glad to profit by them; there is, however, no occasion to invest a simple step like the opening of the antrum with all the dignity of a procedure requiring extraordinary skill and perspicacity, nevertheless a perusal of some recent contributions to mastoid surgery still shows a disposition to magnify the difficulties of this step beyond all reasonable bounds. One might almost imagine that the antrum, instead of being a space with fixed boundaries, was some sort of magic, disappearing chamber, of most elusive and unstable properties, to be found now here, now there, and again vanishing completely and not to be found at all; that an operator must be continually alert to entrap it when momentarily at rest and transfix it with a probe or chisel and thus summarily terminate the baffling pursuit.

The air of mysticism which surrounded the rules governing the determination of the site of the antrum began to be dispelled when the use of the chisel for opening the mastoid bone and removing the osseous structures layer by layer was first advocated by Schwartze, and with the further development of this method and the more extensive removal of bone which has been practiced recently, the necessity for formulating and retaining in the memory any great number of rules has disappeared, and we now rely with confidence and security upon finding the antrum *in 99 per cent. of all cases either in whole or in part within the boundaries of the suprameatal triangle* as enunciated by MacEwen in his magnificent classic, "Pyogenic Diseases of the Brain and Spinal Cord," page 297. Within this area the antrum will in whole or in part always be found. The cavities vary considerably in dimensions, conformably to the size and shape of the mastoid process, being wide and shallow when the process is broad and flat and more contracted and deep when the process is narrow and round.

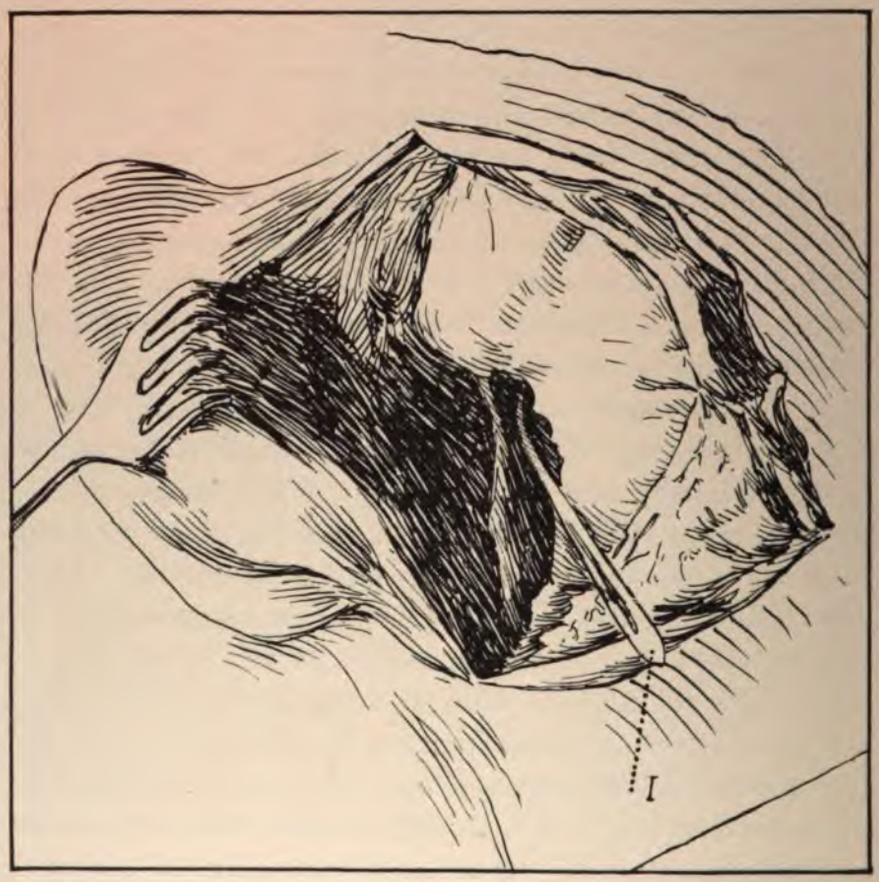
The walls of the antrum may during the progress of proliferative osteitis of the mastoid process, as the result of chronic mastoiditis, be so far encroached upon that the cavity becomes materially reduced in size and its exposure is attended with increased difficulty because of the flint-like hardness of the greatly thickened cortex which lies above it, the removal of which necessitates a slow and laborious procedure. Cases have indeed been cited and continue to be reported, although much less frequently than formerly, in which the inroads of productive osteitis (osteosclerosis) have resulted in entire obliteration of the antral space and complete sclerosis of the mastoid process. Such a condition is readily enough conceivable, although the writer in an experience gained in opening over 800 mastoid processes (operative and anatomical) has thus far failed to encounter it.

The natural inference is that such anomalies must be extremely rare; another inference, not perhaps quite so charitable, but still apparently warranted, is that some reported instances of absence of the antrum would scarcely survive the scrutiny of critical investigation.

It has been the fortune of the writer upon several occasions when reoperating cases which had failed of satisfactory healing in other hands, to find and open for the first time a deeply situated and narrow antrum, extending perhaps well forward over the superior wall of the bony meatus, which had failed to reveal itself to the first operator and which has since, in one instance at least, adorned and augmented the statistical pages of a record devoted to the preservation and tabulation of anatomical anomalies. It seems a rational conclusion that many reported cases of absence or obliteration of the antrum have their origin in the timidity or incompetence of the operator, rather than in the structural changes of the temporal bone, and at the present day all reported failures to find an antrum, unless recorded in the practice of an operator of great recognized skill and experience, should be taken "cum grano salis." It is the firm conviction of the author that obliteration or absence of the antrum is an anatomical peculiarity which occurs with much less frequency than the proportion commonly attributed to it, and that a thorough search would reveal it in most instances extending upward and forward beneath the temporal ridge and over the superior wall of the bony meatus, in the direction of the zygomatic cells.

When the diploic structures have been removed by a curette through the opening in the bone as indicated in PLATE X, the antrum is then easily accessible, and it frequently happens that, as a result of the purulent process already enacted, there is solution of the cellular tissue in the vicinity of the antrum and a tract

## EXPLANATORY NOTE TO PLATE X.

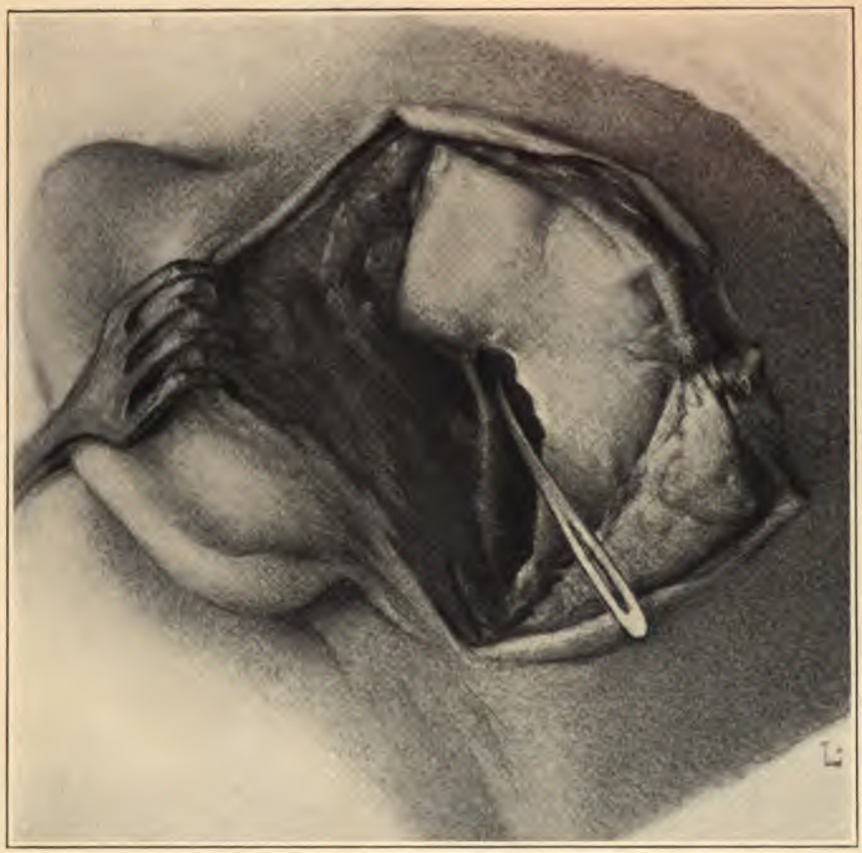



This plate demonstrates the absence of the pneumatic structures which presented in the opening in the cortex in Plate IX and which the curette has removed, resulting in a large cavity in the mastoid process, long and narrow in contour, with encircling overhanging cortical margins.

The situation of the antrum, into which a probe (1) has been introduced, and the distinct curving outline of the thin posterior wall of the bony meatus are clearly shown.

It is but a few years since the mastoid procedure, even in the most competent hands, ceased at this stage.

PLATE No. 10.



of carious bone leads directly into it, in which event a small curette will quickly separate the softened bone and open the antrum widely. When, however, the intercellular osseous structures are still of normal consistency and there is no fistulous or other guiding tract leading to the antrum, the cellular tissue constituting the outer wall of that space is conveniently perforated by a small sharp-edged curette, which is placed in the opening in the bone at a situation corresponding with the upper and anterior angle of the suprameatal triangle, and with a rotary movement made to bore through the intervening layers of spongy bone (following the direction of and keeping close to the superior posterior quadrant of the bony meatus with the lower border of the temporal ridge as a boundary, above which one must not trespass), which are usually thin and brittle and offer but feeble resistance.

This method of procedure has proved so satisfactory and reliable that other instrumental aid is seldom required. Occasionally, however, the cells constituting the outer walls of the antrum become very firm and resisting, exhibiting density almost equal to the cortex, under which circumstances the operator must depend upon a gouge, and, in any event, greater precaution will be necessary to guard against injury to neighboring vascular and nervous structures than where the slower but more easily controlled curette can be employed upon friable and crumbling spongy bone.

When the operator has penetrated the bone to a depth at which the antrum is usually encountered, but still the cavity fails to reveal itself, while the osseous tissue at the bottom of the opening is very dense, he should, before exploring further, pass a probe gently but firmly into the bony meatus along its posterior wall (insinuating it between the bone and the fibrocartilaginous meatus) to the very bottom, which is to say, into the tympanum.

This procedure will inform him regarding two matters of importance: First, whether the direction of the bony meatus is unusually oblique, inclining sharply forward toward the face, in which event the antrum will be situated correspondingly further forward in the mastoid process and a slight change in direction will cause the chisel or curette to enter it without more ado. Second, and more important, the passage of the probe will clearly indicate the depth of the tympanum, which usually lies about two millimeters (2 m.m.) deeper than the floor of the antrum. If, then, the probe shows the tympanum to be situated several millimeters deeper than the bottom of the opening which the operator has thus far made, the discrepancy will justify him in cautiously persisting with his gouge or curette until the depth of the mastoid opening closely approximates that of the tympanum, before attaining which depth, the discovery of the antrum, it is safe to assume, will allay his anxieties and relieve his perplexities.

Should the above mentioned measures fail to solve the problem and the antrum still refuse to disclose its whereabouts, we have by no means exhausted our otological resources, as a simple expedient will demonstrate. We know that the tympanum communicates with the antrum by way of the aditus, which physiological conformation may be readily turned to practical account by passing a probe, with its point bent sharply into a hook, between the fibro-cartilaginous canal and the posterior wall of the bony meatus, into the tympanum and hooking the tip of the same beneath the tympanic ring in the superior posterior quadrant. In this manœuvre the probe must traverse the aditus and enter the antrum, and may be held in position as a guide to that much-sought-after space until the gouge, cutting with care toward its now recognized situation, exposes it.

The necessity for such a procedure (as the passage of a probe

from the tympanum into the antrum) in cases of mastoiditis originating in *acute purulent processes* of the middle ear, is to be deprecated, inasmuch as the accompanying traumatism will likely induce some dislocation of the ossicular chain with subsequent disordered function. Fortunately, however, the contingency which will demand the step is, in acute conditions, exceedingly remote; while in chronic suppuration of the middle ear which is commonly accompanied by mastoid sclerosis and contraction of all the cavities of the mastoid process, and is hence more likely to furnish a small and not easily detected antrum, the inroads of disease upon the contents of the tympanum leave the contained structures in a condition in which any slight additional traumatism is a matter of entire indifference.

All rules designed to simplify the search for the antrum may be epitomized as follows: Make an opening, within the supra-meatal triangle and close beside the bony meatus at its superior posterior quadrant, which shall follow exactly the same direction and inclination as the meatus itself and be separated from it by the thickness of its posterior bony wall only, said opening to be driven, if necessary, to an extreme depth, but two millimeters (2 m.m.) less than that of the tympanum. If any antrum exists, such a shaft will inevitably strike it.

As soon as admission is obtained to the antral cavity, carefully remove by means of a curette all softened bone in the vicinity until an opening is obtained through which the roof and sides of the space can be thoroughly and conveniently explored, after which further removal of contiguous bony structures may be temporarily postponed and resumed to advantage at a later stage of the operation after the removal of the zygomatic cells has converted the antrum into a shallow cup.

**The opening of the antrum is the step of fundamental importance in the performance of the mastoid operation,**

**inasmuch as this space, when filled with pus, speedily becomes a distributing centre for infective material throughout the entire mastoid process.**

When infective products accumulate within the antrum, the mucous membrane investing that cavity soon becomes swollen and œdematous, as a result of which, the innumerable minute openings communicating with the adjoining pneumatic spaces are promptly occluded, and thus a protective agency is exercised which delays, and sometimes prevents the invasion of the mastoid cells.

One must, however, be apprehensive of a second and less favorable result of the swelling of the mucous membrane lining the antrum, namely, of closure of the aditus or obliteration of the avenue of exit for pus, should it collect in larger quantity than the cavity can readily contain, into the middle ear. This is an element of positive danger, for if the inflammatory action be at all violent infective products will accumulate rapidly, and having no outlet, will quickly under pressure filter through the narrow channels leading into the mastoid cells and institute a suppurative osteomyelitis.

The mucous membrane when swollen becomes, moreover, exceedingly vulnerable to the action of pus, and infective products find ready entrance into veins and lymphatics when distended and tortuous as a result of engorgement, and once these channels have become infected dissemination throughout the contiguous bone, and sometimes to remote structures, speedily ensues.

The antrum is, with occasional exceptions, the largest pneumatic space in the mastoid process (the tip cell now and again assuming extraordinary proportions), and hence must have relatively thin walls in at least two directions, viz., upward toward the tegmen antri, pus escaping in which direction will

threaten the contents of the middle fossa; and backward, toward the sigmoid groove, erosion of which will jeopardize the sigmoid sinus.

As soon as pus within the antrum is demonstrable, its immediate evacuation is imperative, lest the infective elements escape thence into the more dependent cells (in the destruction of which happily their energies may be expended) or precipitate a still more to be dreaded intracranial complication.

Especial emphasis has been imposed upon the importance of opening the antrum widely and converting it into a shallow bowl, inasmuch as the antiquated procedure of syringing through the tympanum has long since been recognized as inadequate and by modern surgeons abandoned.

## FAULTS OF TECHNIQUE.

The most common fault observed in removing the cellular structures from the mastoid and in prosecuting the search for the antrum is a disposition to persist in the use of the chisel upon the spongy bone and a tendency likewise to curette the contents of a cavity which cannot be inspected. The error most commonly committed in the search for the antrum is the practice of seeking it too far below the temporal ridge. Beginners in mastoid surgery are inclined to persevere in the use of the chisel beyond the point where it is either practical or desirable, failing to realize that other appliances are safer and more efficient. So complete is the surgical equipment of the present day that an operator may be certain, at any stage of the procedure when he seems to be making unsatisfactory progress or appears to have encountered insurmountable obstacles, that he is not employing the appliance which is best adapted to the accomplishment of his purpose; in other words, he is not using the proper instrument. As has already been stated, the necessity for the use

of the chisel in most cases ceases with the removal of a sufficient area of cortex to admit of exposing the contents of the bone, and thereafter curettes and rongeurs should be relied upon.

There are, however, occasional mastoid processes encountered whose cellular elements are so scanty in amount, either in consequence of nature's vagaries or because of a former productive osteitis, as to render the density of the body of the bone almost uniform with that of the cortex; in such processes the chisel furnishes the only proper solution of the difficulty, with this single exception, however, the structures contained within the bone are most expeditiously and safely removed by the curette and rongeur.

The beginner should lay to heart this injunction, **desist from using the chisel and employ the curette and rongeur at the earliest moment possible in the operation.** It is better to be cautious than sorry. The forcible and reckless use of the curette is an exceedingly common fault of technique, which accusation, indeed, is by no means restricted in its application to the novice in mastoid surgery; for some unaccountable reason the notion seems to prevail that no special caution need be exercised in employing the curette even when the instrument is buried from sight in a deep cavity, the boundaries of which are composed of diseased and crumbling bone.

Sponging of the mastoid opening should keep pace with the curetting, in order that the operator may at all times plainly see the structures with the removal of which he is engaged; scraping vigorously upon a tissue which cannot be closely scrutinized and which is in relation with essential structures of the ear is a grave surgical mistake, and many injuries to the sigmoid sinus and to the facial nerve have been inflicted because of just such unpardonable negligence.

In the search for the antrum the error most commonly com-

mitted is of judgment as to direction; in consequence of which the opening made in the bone with the intention of exposing the antrum is apt to pass beneath the floor of that cavity. This source of error may be eliminated by constantly noting the relation which the opening in the mastoid bears to the temporal ridge.

As a matter of operative experience, whenever search for the antrum is prolonged it will ultimately be discovered close beneath the floor of the middle cranial fossa, that is to say, always above, instead of below, its usual situation.

# CHAPTER XI.

# THE REMOVAL OF THE MASTOID TIP.

## THE REMOVAL WITH THE RONGEUR OF THE EXTREME MASTOID TIP, INCLUDING A PORTION OF THE MEDIAL PLATE,

**characterizes the sixth step of the operation. The removal of the extreme tip is a distinctive step of the modern operation in the performance of which a rongeur with a broad beak is employed to advantage.**

**The bone is cut away as deeply as the occipital groove in the medial plate, which procedure results in the exposure of the tendinous attachment of the posterior belly of the digastric muscle with its fascial covering and prepares the remaining portions of the mastoid process to be subsequently attacked with the rongeur under the most favorable conditions possible. A branch of the stylo-mastoid artery is sometimes divided in the performance of this step. The bleeding is insignificant.**

The procedure for the removal of the tip of the mastoid process is most simple in its performance. One blade of a broad

rongeur is introduced within the opening in the bone which the deepened grooves afford and which serves as an admirable fulcrum or support; the second blade is then carried beneath the extremity of the tip, in close contact with the cortex, as far downward as the situation of the occipital groove, a varying distance, but approximately one-third of an inch. All the bony structures included within the grasp of the instrument are cut through at one effort, exposing the deep fascia investing the origin of the tendinous attachment of the posterior belly of the digastric muscle (see Plate XI). Some fibres of the tendon are apt to cling to the portion of bone bitten off by the rongeur and should be divided by scissors or knife rather than dragged forcibly apart, for when the fragment of bone is wrenched free of its ligamentous attachments, it oftentimes pulls out from the neck long thin strips of muscular tissue and deep fascia and thus opens channels for the entrance of infective products escaping from the wound above. Such impatient technique has been responsible for occasional attacks of cellulitis of the neck which were productive of pain, temperature, and anxiety upon the part of the patient and which have subjected the surgeon to embarrassing interrogation at least; these annoyances a little judicious precaution would have obviated.

In cutting away the tip, a small branch of the stylo-mastoid artery is not infrequently divided; the attendant hemorrhage is usually a matter of no significance, save as it momentarily obscures the details of the surgical field, and may be disregarded. Should it, however, happen that an unusually large vessel is distributed to this part and the bleeding prove annoying or persistent, a smart tap with the mallet upon the spongy bone from which it spurts will speedily arrest it; or a nip from the rongeur forceps, employing only sufficient force to compress or indent but not to cut the bone, will serve the same purpose.

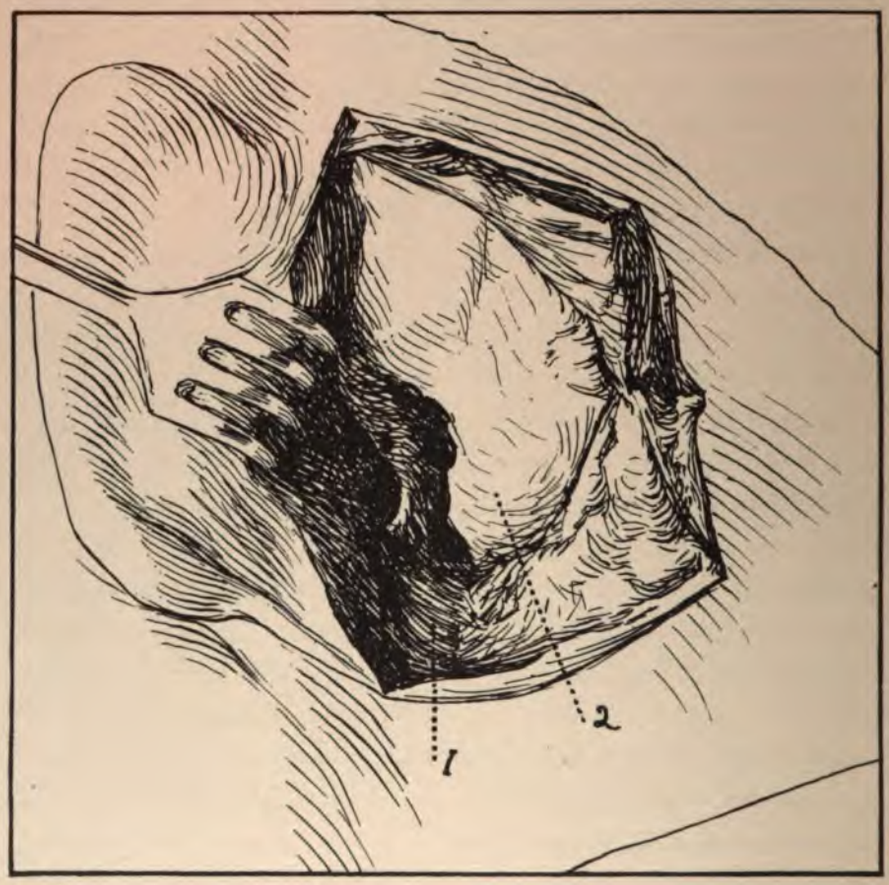
The removal of the tip, which is now practiced as a routine procedure in the simple mastoid operation, does not require such extensive sacrifice of the cellular structure as is demanded for the surgical relief of a certain well recognized type of mastoid inflammation which is accompanied by a hard circumscribed swelling of the neck immediately beneath the ear. This mass imparts upon palpation a sense of brawn and firm resistance and is usually exquisitely sensitive to the touch; the movements of the patient's neck are always more or less restricted and the head is usually inclined somewhat toward the affected side in an effort to diminish the tension on the inflamed structures.

This variety of disease, which has been designated, from the name of the surgeon who wrote the first classical description of its symptomatology and pathology, "Bezold mastoiditis," pursues a very unusual course in the mastoid bone, the infected area comprising only a narrow strip of deep petrous cells.

In the ordinary type of mastoiditis the antrum acts as a distributing centre for infective products through numerous avenues and in many directions, disseminating pathogenic microorganisms with an impartial disregard for the sanctity of any particular part of the bone, in consequence of which method of attack large areas of tissue participate in the suppurative process, oftentimes simultaneously, in widely separated regions of the mastoid apophysis.

In the Bezold variety of mastoiditis a very different process is enacted; instead of a widely distributed suppurative inflammation we have to deal with a very narrow, sharply defined area of infection which invades at first a few cells in the floor of the antrum and extends thence into the deep petrous cells immediately beneath, whence the inflammation, following the sheath of some vein or lymphatic, proceeds along a narrow isthmus of spongy

## EXPLANATORY NOTE TO PLATE XI.




This plate demonstrates a radical departure from the method of Schwartze's operation, namely, the removal of the tip of the mastoid process as far downward as the medial plate. The layer of deep fascia (1) covering the attachment of the digastric muscle is clearly shown and the overhang of the remaining cortex (2) is very noticeable.

PLATE No. 11.

bone midway between the premastoid lamina anteriorly and the sigmoid groove posteriorly until the mastoid tip is reached deep down beneath the occipital groove. The cellular structures in this region soon fall a prey to suppuration, whereupon in successive stages the thin cortical bone of the groove quickly becomes eroded, then softened, and finally perforated, thus providing an exit for the escape of pus into the tissues of the neck beneath the deep fascial covering of the posterior belly of the digastric muscle which finds attachment for its fibres in this situation.

It seems very extraordinary that a suppurative process should extend so great a distance from the original source of infection and still remain circumscribed within such narrow limits instead of involving considerable areas of contiguous tissue in the course of its long journey from one extremity to the other of the mastoid process. Cases are indeed observed in which extensive destruction of such adjacent bony structures accompanies suppuration of the deep petrous cells with digastric or medial plate perforation.

Such varieties of mastoid suppuration, however, cannot properly be regarded as characteristic examples of Bezold mastoiditis, for in the typical Bezold inflammation the operator will often find it necessary before reaching the infected area to remove the entire cellular contents of a mastoid apophysis which appears macroscopically to be thoroughly healthy.

In removing the deep petrous cells which are involved in the purulent process the operator must continually bear in mind the proximity of two of the most important structures which traverse the temporal bone, namely, the facial nerve anteriorly and the sigmoid sinus posteriorly, for it is along a narrow channel of cellular bone equidistant between them that the Bezold inflammation pursues its boring course through the mastoid bone.

The scanty supply of cells through which the infective path has travelled having in part undergone disintegration and absorption, is most safely and effectively removed by careful use of a narrow curette; the instrument should be restricted in the method of its employment to a gentle stroke in the direction of the long axis of the mastoid process, for example, from the tip upward toward the antrum. All the diseased bone quickly succumbs to cautious and persistent curetting, and the glistening surface of the sigmoid groove posteriorly is soon revealed, thus speedily relieving the perplexities of the anxious operator, while the dense and sclerotic character of the bone in front clearly indicates the dangerous proximity of the facial canal pursuing its course in the thin premastoid lamina.

When the diseased cellular structures along the fistulous tract of the mastoid inflammation are cleared away the perforation in the medial plate through which infection has invaded the deep structures of the neck will be plainly seen. All the softened and eroded bone surrounding it must be cut away with the rongeur after the muscular attachments have been carefully separated from the vicinity of the occipital groove. With the completion of the procedure for clearing away the dead bone at the tip there remains an inflammatory condition in the neck which demands further attention. The swollen and indurated mass immediately beneath the ear is due to infection of the parts caused by the escape from the mastoid process of the infective agent whose mischievous activity has created havoc within the bone.

That the inflammation may be speedily relieved by freely dividing the swollen tissue from the integument down to the digastric muscle is certainly true, and if the process in the neck has existed for any considerable length of time the necessities of the case would appear to admit of no alternative. Such an

incision when it has healed by granulation unfortunately produces an unsightly and prominent scar, for being situated below the auricle there is no adequate means of concealment; it is especially desirable, therefore, to spare the sensibilities of the patient the shock which such a procedure inflicts, particularly if the victim of the expedient is a woman, to whom such a cosmetic defect is a source of daily mortification and distress.

The writer's experience would indicate that in the majority of circumstances the following rule may be relied upon for guidance in the two conditions which chiefly characterize infection of the neck from Bezold mastoiditis.

In the one instance when the induration has existed for a brief period only (twenty-four to forty-eight hours) and fluctuation cannot be appreciated on palpation, and further when upon cutting away the medial mastoid plate we do not find a mass of granulations pouting from the mouth of a suppurating sac which burrows beneath the deep fascia, we are justified in endeavoring to express any pus which may be present in the tissue by manual pressure applied upon the muscles of the neck from below upward.

This manœuvre is based upon the expectation that the avenue by which infective products were conveyed to the tissue having been closed and such pus as was present having been expressed, the structures will thereupon return to a healthy condition and the patient be spared the infliction of an unsightly deformity.

In the second instance when the induration of the neck has existed for several days with or without recognizable deep fluctuation, and when upon removal of the medial mastoid plate a mass of granulation tissue is found about the mouth of a suppurating and granulating sac which burrows beneath the deep fascia and from which pus wells up in response to pressure from

below, it is no longer discretionary with a surgeon but is incumbent upon him to incise the swollen parts, freely dividing the integument as well as the muscular tissues and fascia down to the abscess cavity in the digastric fossa.

When the suppurating sac has been laid open the necrotic granulations and plastic material lining its walls should be scraped with a dull curette with sufficient force to destroy them and leave a healthy granulating surface exposed. The wound thus created should be lightly packed with iodoform gauze and permitted to granulate, thereafter being treated like any other open wound and dressed after the manner of the mastoid wound, of which it becomes simply an incidental accompaniment.

A consideration of the wisdom of removing the tip of the mastoid process as a routine procedure in suppurative mastoiditis revives the discussion as to the advisability of a complete as against an incomplete operation.

The exponents of the mastoid operation may be classified under three heads in the order of their numerical superiority.

1. The advocates of the modern procedure embodied in the complete operation as already described.

2. The timid and reluctant operator who vindicates his position with the homily of conservatism. He says he removes the tip and adjacent cellular structures "when conditions warrant it." The indications, however, for so radical a procedure, in his judgment, seldom arise until necrosis has progressed to the extent of maceration.

3. The few irreconcilables who still cling to the long since discredited mastoid drill. As regards the removal of the entire mastoid process they never encounter a case in which such a step would be justifiable, nevertheless they affirm that their patients always recover; but oftentimes not until they have escaped into the hands of a more progressive and skilful colleague, we may add.

The writer entertains no doubts and is embarrassed by no misgivings as regards the standard beneath which he desires to be enrolled, and unhesitatingly affirms his emphatic endorsement of the more radical measures.

The exposure of the antrum and the evacuation of its inflammatory contents has by all operators long been recognized as the fundamental principle of the mastoid operation, next to which in degree of importance the removal of the tip must be esteemed as the most essential and characteristic step of the modern procedure. Let us then consider for a moment how the attitude of those who regard the removal of the tip as an extravagant and unjustifiable measure and a needless mutilation of the patient, is to be reconciled with conditions which are clearly demonstrable upon careful consideration of the anatomical peculiarities of the structure in question.

In a majority of persons the lower third of the mastoid process, embracing that portion which is commonly denominated the tip, consists of a very thin layer of cortical bone beneath which is an aggregation of pneumatic or diploic cells of variable size and number; they are individually large, if the pro cess be of a purely pneumatic type, smaller if we are dealing with a pneumo-diploic variety, and still smaller when the structure is, as in small children and occasionally in adults, strictly diploic or cancellous; very rarely it happens that as a result of proliferative osteitis (in the course of chronic mastoiditis) the tip undergoes absolute sclerosis, in which event the cellular character of the structure disappears and the bone becomes of uniform and flint-like density.

With the exception of the last mentioned variety, which from its extreme rarity may be disregarded in this consideration, the result of leaving the tip *in situ* is the same.

When purulent mastoiditis is in progress and the inflamed

bone has been opened after the method of Schwartze (with the intention of not removing the lower third), the osseous tissues immediately bordering upon the antrum are cut away and investigation with a probe or curette is then directed downward toward the tip, beneath the overlying cortex. (See Plate B.)

Sometimes the probe enters immediately into a spacious cavity, representing the coalescence of a large tip cell with several adjoining cells, which have been converted into a receptacle for pus, or it may encounter readily recognizable softened and macerated bone which can be easily scraped out mixed with pus and granulations, or again the structures beneath the cortex which are accessible to the probe may be of a consistency which renders exceedingly unreliable the determination as to whether or not the suppurative process has extended to such a distance beyond the limits of the antrum and begets a suspicion that we may be dealing with normal diploic bone.

Inasmuch as the operator cannot plainly see, through the hole in the cortex, the details of the interior of the mastoid, and since under no circumstances will he open it further in order that he may assure himself of its soundness, he completely exposes the inconsistency of his position when he insists upon scraping out the cellular structures from the apex; such exenteration or excavation or reaming out of the tip leaves a thimble-shaped extremity to the bone the thin surrounding walls of which are represented anteriorly and posteriorly by the outer and inner tables of the skull respectively, and inferiorly by the medial plate, all dense cortical bone now almost entirely deprived of nourishment save such inadequate supply as may be derived from the periosteum after reapposition of the flaps and hence in a condition which favors further death of bone.

Such are the anatomical features which the tip presents in every instance in which it has been thoroughly curetted of its

purulent or disintegrated contents and the thin bony shell preserved for the sake of muscular attachment or supposed cosmetic effect. It is impossible even in those processes which are very broad and convex (and hence easiest to investigate) to inspect the inner surface of the thin walls which remain after vigorous scraping, and a careful study of the shape of the cavity thus created will convince even the most skeptical that a thorough cleaning of the irregular and tortuous recesses of the bone through a cortical opening is a physical impossibility as well as a hazardous expedient.

The preservation of the tip is at best attended with risk of leaving in hostile possession undiscovered areas of carious bone which must in any event materially retard convalescence and are liable in many instances to necessitate secondary operation; moreover there is reasonable ground for the belief that by so much the more thoroughly as the bone is curetted, and by so much the more as the thickness of the cortex is reduced, in corresponding proportion is the vascularity and vitality of the part diminished and the likelihood of future necrosis increased. *The refusal to remove the mastoid tip under any circumstances* is an attempt to perpetuate an unscientific and unsurgical measure which does not commend itself to good judgment; the advocates of this inadequate procedure represent a class of operators which is to-day numerically very small. They need not therefore be seriously considered.

The attitude of those who remove the tip only when it is markedly discolored and softened is vindicated, at least to their own apparent satisfaction, upon the ground that the deformity resulting from the operation is in this manner greatly diminished and in the conviction that the liability to loss of power in the sterno-mastoid, trachelo-mastoid, and splenius capitis muscles is thereby in similar degree reduced. In view of which belief

unless the cortex of the tip is in a state of practical maceration they deem it wise to scoop out the contents of the inflamed bone and leave the hollow thimble-shaped apex as a support for the above mentioned group of muscles, indulging the hope that sufficient vitality may remain in the osseous structures to promote a productive inflammation, when cicatrization will ensue, or, failing that, they trust that in the course of granulation of the wound such carious bone as remains will undergo absorption or separate and come obligingly to the surface.

This incomplete procedure subjects the patient to the likelihood of a secondary operation, in the performance of which the tissues to be removed will surely embrace all those included in the complete primary operation, and perhaps others as well and the resulting cicatrix of which will be at least as extensive and more unsightly.

To the mortification of the increased scar with the secondary operation there is to be added to the reckoning the acute distress of mind and physical discomfort inflicted upon the patient for a second time, and it is needless to assert that the reluctance of patients to undergo the primary operation is not a circumstance comparable to the absolute repugnance with which they contemplate a repetition of the performance, either as the result of injudicious conservatism upon the part of the operator during the first procedure or from any other cause whatsoever. Could the surgeon take counsel of his unconscious patient upon the operating table and explain that he was about to refrain from removing certain dubious structures in the interest of a less conspicuous scar but with a *remote* possibility, not to say probability, of further surgical interference at a later period, there is no room for doubt that a startling unanimity of opinion would exhibit itself upon the part of all patients in favor of the complete operation. The writer entertains very decided doubts

that any person would voluntarily elect the incomplete procedure, with its risk of later repetition, in place of the complete operation with the certainty of healing, upon a promised compensation as meagre as a slightly less extensive but equally prominent cicatrix.

The writer, as an advocate of the complete operation, puts himself on record as in favor of removing all the cellular structures of the mastoid in the interest of the patient's welfare; he recognizes full well the absurdity of the pretension, upon the part of even the most experienced operator, that he can with any degree of positiveness determine macroscopically precisely where dead bone ends and living bone begins, the more especially when the structures under suspicion are concealed beneath overlying cortex through a contracted opening in which it is possible to obtain only a most superficial inspection.

Let us further examine the defense presented by the operator who does sometimes remove the tip, but does it with reluctance and hesitation, and see if there are no other defective links in his armor.

First as to the objection that an essential element in the support of the neck and the maintenance of the erect posture of the head is impaired by the complete operation. The writer believes that his personal experience is amply sufficient to refute this argument and establish the fallacy of the contention; he has performed four hundred and fifty mastoid operations, in the greater number of which most of the tip was removed and in the last two hundred and fifty of which all the mastoid apex was taken away. The vast majority of these cases were among the very poorest class of a metropolitan population, unskilled laborers, men dependent upon their physical strength for a livelihood and to whom any impairment of that force would prove a calamity; among the number were longshoremen, street-pavers, hod-

carriers, blacksmiths, plumbers, butchers, paper-hangers, carpenters, and representatives of nearly every trade and art, men who were required to carry burdens upon their shoulders and backs and to whom any muscular disability would have meant loss of employment. By no one of this large number has any complaint ever been registered against the perfect performance of function of the muscles so freely separated from their insertions, which testimony would appear to furnish satisfactory evidence that the subsequent reattachment of the disrupted tendons to the contiguous bony supports is in all respects adequate for the performance of hard labor and in no sense productive of impaired physical force. The only danger of loss of muscular power to be apprehended from operations in this region is liable to follow the complete separation of the attachments of the sterno-cleido-mastoid muscle, in the course of the jugular operation for sinus thrombosis as it is sometimes incorrectly performed; the damage is inflicted by dividing the spinal accessory nerve, as a result of which accident in a certain proportion of cases permanent paralysis of the trapezius muscle ensues; one such unfortunate occurrence has been reported during the last year as an embarrassing complication of operation for the extirpation of deeply situated tubercular glands in the neck. The danger does not properly concern the uncomplicated mastoid operation, or even the Bezold variety; and may be dismissed without further consideration.

The second objection raised against the complete operation upon the score of deformity may be satisfactorily answered in this wise: The degree of deformity is largely dependent upon the method of construction of the cutaneous flaps. When the primary or curvilinear incision is made too close to the auricle, that member as the wound heals is drawn inward and may assume a position slightly closer to the head; when the same in-

cision is made too far back and the anterior flap is redundant. it is apt to become infiltrated and swollen and cause sagging of the auricle, but the disfigurement is seldom great in either of these conditions. So much for the appearance of the auricle.

As regards the sinking of the scar and the post-auricular deformity ensuing upon the removal of the tip, these defects are oftentimes not noticeable at all, such being almost uniformly the experience in patients who have a moderate amount of fat in the areolar tissue underlying the integument; the depression is naturally more pronounced in thin or emaciated persons, but seldom constitutes any special deformity even in such extreme instances.

As concerns the scar, it does not extend below the lobule and is furthermore situated behind and within the shadow of the auricle; it cannot therefore constitute a very conspicuous exhibit, and when the additional concealment afforded by the hair is considered the operation and its attendant horrors fades with the passage of time into a mere recollection which the patient recalls to a more vivid realization by occasionally interrogating the mastoid region with his finger.

As an embarrassing element the unsightliness of the cicatrix has long since ceased to occasion concern, and beyond exciting interest for purposes of display to the curious or inquisitive among the intimates of the former patient, is forgotten.

The primary incision for the complete operation is no more extensive than the corresponding incision for the incomplete operation and occasions no greater scar, while as regards the secondary incision it lies beneath the hair throughout its entire extent, and so far from being obtrusive can with difficulty be recognized a few weeks after healing.

## FAULTS OF TECHNIQUE.

The most common fault of technique observed in the removal of the mastoid tip is a result of impatient haste rather than of unfamiliarity with the operative steps. It is the custom of many competent operators to remove the entire apex of the mastoid bone with the single bite of a rongeur having a strong, broad jaw, and it very frequently happens after the bone has been cut through that some bundles of fibres of the deep fascia remain undivided and cling firmly to the fragment of bone which is held in the beak of the rongeur; instead of separating this tissue from the bone with scissors, the operator, in his haste, is apt to tear the bone loose from its entanglement, with a sudden and forcible wrench, with the result that the attached fibres are dragged from their bed in the neck. Such impatient and inconsiderate technique usually inflicts great discomfort upon the patient, for an attack of cervical cellulitis is likely to supervene, the swelling incident to which may necessitate removing the stitches and re-opening the wound. Inconsiderate haste in operating begets faulty and slovenly technique, and is usually displayed at the expense of thoroughness.

## CHAPTER XII.

# THE REMOVAL OF THE MASTOID CORTEX AND CELLS OVERLYING THE SIGMOID GROOVE.

## THE REMOVAL OF THE MASTOID CORTEX AND CELLS AS FAR BACKWARD AS THE POSTERIOR BORDER OF THE SIGMOID GROOVE CHARACTERIZES THE SEVENTH STEP OF THE OPERATION.

**After the removal of the tip, the lower third of the process together with the remaining portion of the apophysis as far backward as the wall of the sigmoid groove and as far upward as the floor of the middle fossa can be easily cut away with the rongeur supplemented by the curette (see Plate XII); care must, however, be exercised lest the inner table be violated and the sinus wall wounded as a result of undue or misdirected force in the employment of either instrument.**

The removal of the tip greatly facilitates the succeeding steps of the mastoid operation; the remainder of the lower half of the process is conveniently bitten away with a medium width rongeur from below upward after the manner indicated in Plate XII, successive fragments being quickly separated until the bulging contour of the sigmoid groove manifests itself. **The degree**

**of convexity presented by this structure is by no means uniform and is habitually less pronounced upon the left than upon the right side.** As has already been noted, the external shape of the mastoid process will often furnish a valuable hint of the internal structural peculiarities to be encountered; when very round and narrow the sigmoid groove is sure to lie superficially and to present a prominent protrusion when the cortex is removed (Plate D); on the other hand, if the process is broad and flat the groove projects so sparingly into the process as to be recognized with considerable difficulty. Between these two extremes the variety of manifestations is infinite, but the average sigmoid groove offers a sufficiently conspicuous eminence to attract the attention of an alert operator. When the situation of the groove has been thus clearly indicated, the cortex and subcortical cells overlying it posteriorly—that is to say, in the direction of the occipital bone—should be carefully removed by means of a curette, if the density of the structures will admit of it, or with a rongeur of broad beak; or, in the event of the hardness of the bone resisting these instruments, recourse must be had to the chisel or bur, with the employment of one or several of which appliances the groove will gradually reveal its outlines from below upward as far as the knee. (The course of operation from that point curves forward and removes the softened osseous tissue from the roof of the antrum, exposing the inner table, which constitutes the tegmen antri or the bony base of the middle cranial fossa.)

The process of thus delineating the course of the sigmoid groove is often a slow and sometimes a most arduous task; especially is such the case in mastoid processes which have been subjected to a proliferative inflammation resulting in sclerosis, but while such processes present the greatest mechanical difficulties, the increased density of the bone affords additional pro-

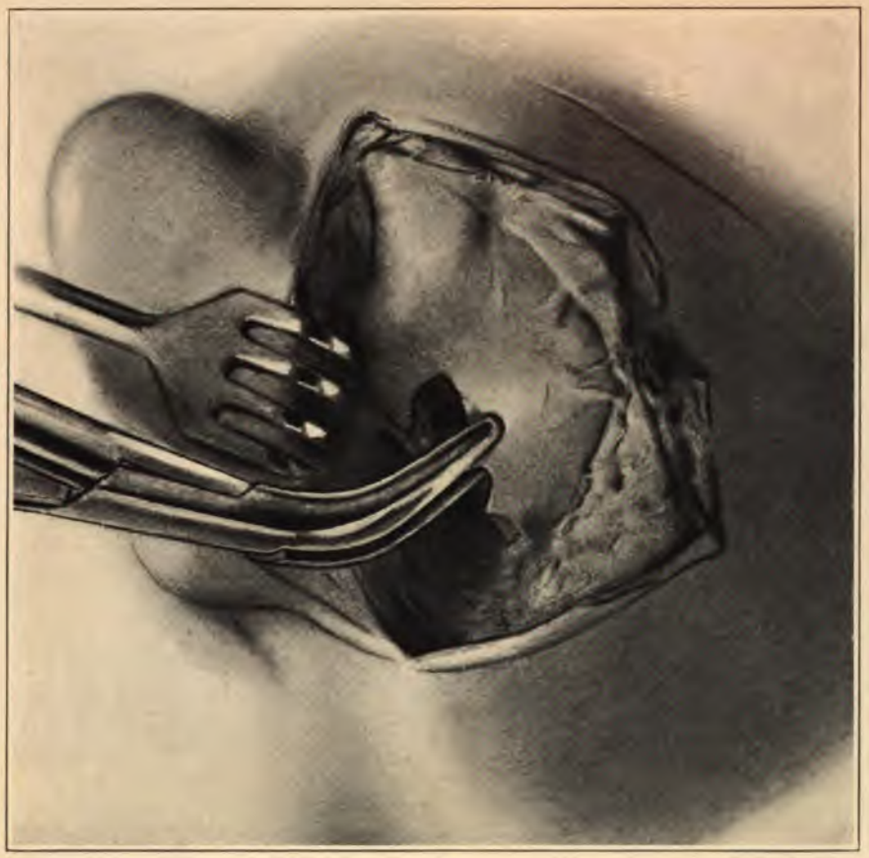
tection to the sinus and it is less liable to become infected under such circumstances than during the progress of suppurative mastoiditis when the osseous structures are softened throughout and in many portions entirely disintegrated, under which conditions the removal of the bone contiguous to the groove requires the exercise of the greatest skill and care, for in its crumbling and brittle state it breaks unexpectedly and the wall of the groove, already eroded, ruptures, with frequently annoying and sometimes disastrous consequences. The sinus is much more liable to injury during this step of the operation than during the subsequent procedure of smoothing off the rough diploic cells which remain upon the groove after it has been exposed by cutting away the surrounding bone. The sinus may be wounded during the employment of any of the instruments enumerated above, either by the instrument itself or by spicula of bone which are dislodged and forcibly thrust against it, or, again, in detaching from its surface fragments of bone which inflammatory adhesions have firmly cemented to its delicate wall, or during the curettage of necrotic granulations springing from the eroded dura, in epidural abscess, for example.

The gravity of accidental wounding of the sinus depends upon several circumstances, the character or size of the wound and the conditions prevailing in the surrounding tissue at the moment of injury being the essential factors. With our increasing knowledge of mastoid and cranial surgery, the dread with which the thought of injury to this great vein so long inspired us has disappeared to a great extent—not but that the lateral sinus still demands and receives at our hands very distinguished consideration, but operators have at length learned that the most violent outburst of this formidable blood stream is amenable to speedy control at the hands of a competent surgeon, while the slight punctures which formerly so disconcerted us no longer occasion especial concern.

## EXPLANATORY NOTE TO PLATE XII.

This plate demonstrates the method of removing with the rongeur (1) all overhanging portions of the mastoid cortex after the softened or disintegrated diploic and pneumatic structures, which are accessible through the opening, have been cleared away by the curette. The serrated margin of the cortex (2) shows the result of successive bites by the rongeur, which when employed to its greatest advantage admits of discarding the chisel and gouge after the completion of the grooves described in Plate IX, save in rare instances of mastoid eburnation.

PLATE No. 12.



The various wounds to which the sinus is liable may be classified, in the order of their relative frequency of occurrence and severity of issue, as follows:

1st. **Those which are dangerous by reason of infection only.**

2nd. **Those which are dangerous by reason both of infection and hemorrhage.**

1ST. *The wounds of the sinus which are dangerous by reason of injection only, must of necessity be very small,* and are usually the result of minute punctures made by detached spicula of bone which have during curetting or sponging been brought into forcible contact with the delicate membranous wall of the vein. The bleeding which ensues upon such injury is in no sense dangerous, although it may be exceedingly annoying because of obscuring the field of operation unless the surgeon is familiar with the legitimate procedure to be adopted under such circumstances, in which event a gauze hæmostat can be so applied (the method of application will be described later) as to offer but slight obstacle to the satisfactory completion of the operation while maintaining efficient control of the hemorrhage. These small perforations of the sinus are liable to occur at any time after the cortex has been removed and the interior of the bone exposed and are fraught with danger in proportion as the infective products of purulent mastoiditis are in a situation favorable or unfavorable for gaining admission to the injured sinus; for example, if, shortly after opening the mastoid and exposing a cavity filled with pus and granulation tissue, an operator should, by injudicious pressure or by the inadvertent slipping of an instrument, force a small fragment of bone bathed in infective material against the sinus wall also immersed in purulent secretion, and should thereby wound the vein, the probability of infection would be very great, notwithstanding that

the injury was insignificant in extent. Under the conditions just narrated the results of sinus puncture are most unfavorable because of inability to quickly sterilize the mass of necrotic tissue lying in close proximity with the wounded structure and likely, in greater or smaller amount, to be carried into the vein by the pressure of the gauze crowded upon it for the purpose of checking the bleeding; the pressure thus made may at the same time force the offending piece of bone still deeper into the sinus wall, thereby converting a small puncture into a rent; fragments have, in fact, been driven through the feebly resisting wall and into the lumen of the vein, in just the manner indicated. The proper measure to institute in such a predicament is to uncover the sigmoid groove as quickly as possible and by cutting it away expose the sinus on each side of the wound, pluck out the detached bone if it can be found, and sterilize the neighboring tissues with a solution of bichloride of mercury 1 to 3000, and in addition flush the part with 85 per cent. alcohol, place a gauze pad upon the small wound in the sinus, complete the dressing, and resign yourself to several watchful days and anxious nights until one week has passed, when, if no symptoms have manifested themselves indicative of septic phlebitis, the operator may feel reasonably assured that he has in that instance escaped a most distressing and sometimes fatal complication.

When good fortune so far attends upon an operator as to delay the mishap to the sinus until all the necrotic material in the vicinity has been cleared away and until surroundings practically sterile exist, the dangers to be apprehended from a small puncture are very greatly diminished and the annoyance from hemorrhage is insignificant for the reason that the wounded vessel is plainly in view and in a favorable position to be supported by gauze padding, preliminary to which the surface should be flushed with bichloride solution and alcohol. It is the practice

of some surgeons to affect, as a revulsion from the former dread of sinus injury, a disregard for that structure and a contempt for small injuries inflicted upon it which experience in nowise justifies; frequent observations, in fact, clearly demonstrate that in the presence of an infective inflammation, any injury to the sinus whatsoever furnishes ample occasion for concern.

With the minute punctures and lacerations which occur the resulting hemorrhage may be annoying and may delay the progress of the operation to some extent, but it does not assume alarming proportions and is easily checked by the application of a small pad of gauze over the bleeding point, upon which pressure is maintained for a brief period until a clot of fibrin has congealed about and occluded the opening, when the pressure can be cautiously and *gradually relaxed and the gauze removed layer by layer* without re-establishing the bleeding; the operation can then proceed unimpeded by the presence of gauze encroaching upon the none too spacious area of the wound.

The method most satisfactory and efficacious for preventing bothersome bleeding from these small wounds is very simple and well worth knowing, and is here described at the risk of proving wearisome in the perusal.

When a small puncture of the sinus has been produced in any manner whatsoever, place a pad of gauze upon it and direct an assistant to support it firmly with the finger-tip; now make use of a strip of iodoform or other sterile gauze of double thickness one inch (1″) or thereabouts in width and one foot long (the double layers of gauze are advantageous by reason of possessing greater substance for purposes of pressure than a single layer); let the assistant quickly remove the temporary hæmostat and the operator be prepared to substitute the gauze instantly in its stead, and after the following manner: place one extremity of the gauze strip—which end is immaterial—promptly upon the

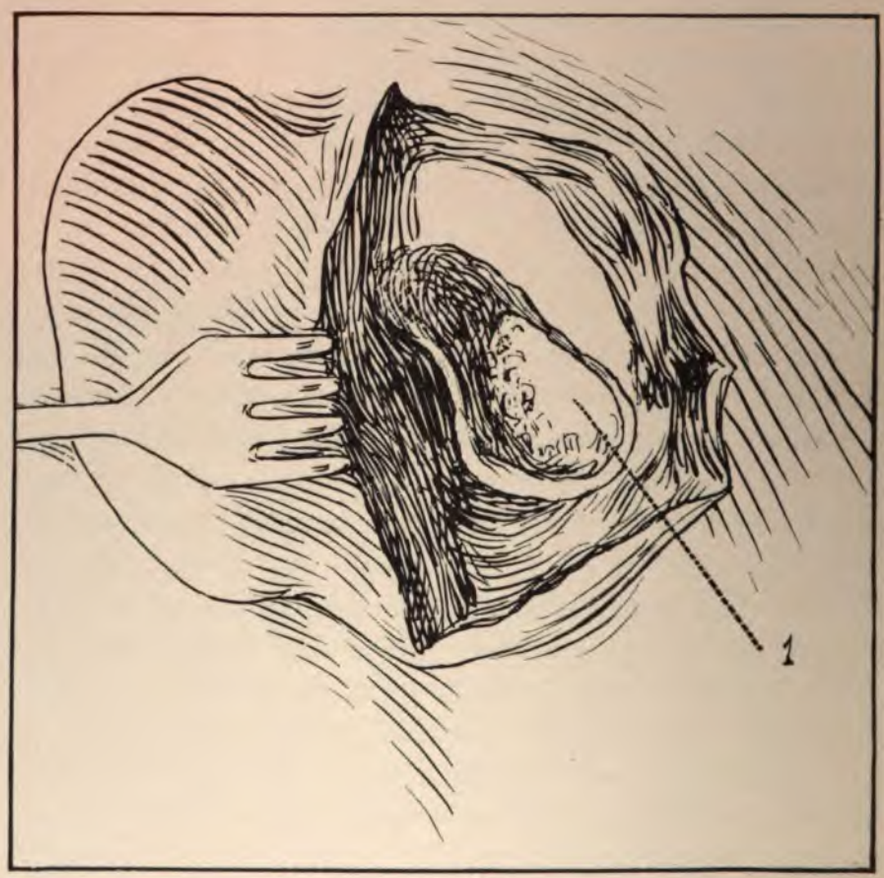
opening in the vessel wall and maintain it in position with the index finger of the left hand; then with the right hand quickly fold about an inch of the strip, which is the continuation of the portion already in position, into a plait and press it upon the layer of gauze first employed; rapidly repeat the manœuvre of folding the remaining length of the gauze strip into layers or lamina of similar width and superimposing them in turn upon the preceding plaits until five or six successive layers are thus piled upon one another like the spokes of a fan when it is closed; the whole strip when thus compactly folded occupies but a narrow compass and admits of continuing the operation without special inconvenience; after maintaining the pressure for a few minutes,—a duty which devolves, of course, upon the assistant,—the operator may remove the support of the finger, not however disturbing the gauze, and observe carefully whether blood wells up beneath the pad; if bleeding is renewed with the relaxation of digital pressure, compression must be reapplied for a brief period and the experiment repeated until oozing ceases; thereupon the folded strip should be straightened out, one fold at a time being slowly and cautiously raised from the wound in order that the intravenous pressure upon the wall of the sinus at the site of the puncture may be gradually re-established and thus prevented from expelling the fibrinous plug which has formed in the opening and which would be unable to resist the expulsive force applied against it in the event of a sudden removal of gauze. It is for just this reason that a plaited strip of gauze is superior to a wad of cotton as a hæmostat—either will accomplish the purpose, that is, stop the bleeding, but a pad of cotton must be taken off practically all at once and the intravenous pressure is restored in an instant, generally with renewed bleeding. The gradual removal of the gauze, however, obviates the difficulty.

2D. *The occurrence of injuries to the sinus which are dangerous to life by reason both of infection and hemorrhage* must be regarded as a serious catastrophe. However the accident befall, whether by a misdirected blow of the chisel, by the slipping of a curette or the overforcible use of a rongeur, matters not,—such injury suddenly converts a case of little or no gravity in which the patient's prospects for recovery were nearly one hundred per cent. favorable, into a critical affair in which the percentage of mortality is very considerable, or, to put the case antithetically, whereas, before the accident the patient was almost certain to recover, after it he is very likely to die.

A wound of the sinus dangerous to life by reason both of infection and hemorrhage constitutes by far the most perilous operative complication of mastoid disease and must represent a considerable tear in the vessel wall during a stage of the operation when infective products are still present. The fact that a large opening has been made will instantly appear, for the great gush of blood which pours from a rent of moderate size is not to be confounded with hemorrhage from any other source and is certainly a disconcerting experience for even the most proficient operator; the patient's prospects are, moreover, seriously jeopardized, and if he is so fortunate as to recover he does so at the sacrifice of one sigmoid sinus, for pressure adequate to control such bleeding will be completely obstructive in its nature and will result in ultimate cicatricial obliteration of the vein.

The first and only consideration in the presence of such a grave mishap will naturally be how most quickly and effectively to check the hemorrhage. This is best accomplished by a large pad of gauze pressing upon the sinus with sufficient force to cause obstruction of its entire lumen. It will rarely be found necessary to thrust gauze into the opening in the vessel walls, unless a tear of extraordinary dimensions exists, in which case

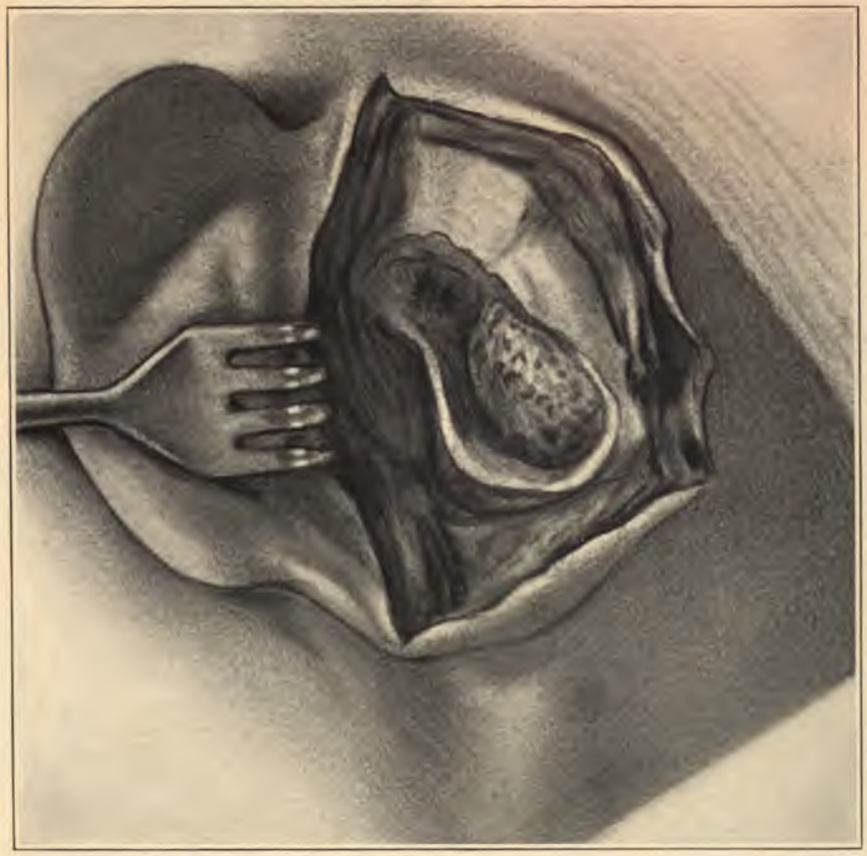
## EXPLANATORY NOTE TO PLATE XIII.

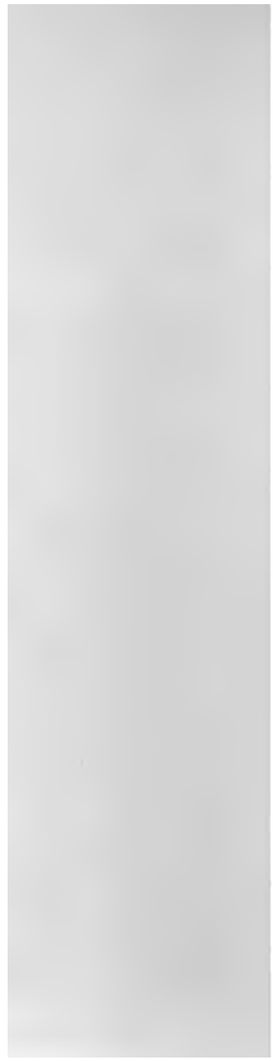



This plate demonstrates the appearance presented by the mastoid bone after the removal of all cortical bone necessary for the complete mastoid operation and before the margins of the bone have been smoothed.

The cone-shaped remains (1) of the diploic structures of the mastoid, beneath which the sigmoid groove lies and the sinus courses (as well as the boundaries of the antrum converted by the removal of the cellular structures at the root of the zygoma into a shallow bowl-shaped excavation) are well shown.

PLATE No. 13.





packing of the sinus is an entirely appropriate procedure and may be indispensable, but as an expedient it is much more difficult of accomplishment than simple external gauze pressure and is less satisfactory in view of the embarrassment which its subsequent removal occasions. At the first dressing the withdrawal of the gauze from within the vein is likely to excite renewed bleeding with the attendant anxiety of a second exposure to possible infection; when in any such event the gauze packing has been withdrawn and is attended by bleeding, no attempt should be made to replace the packing in the calibre of the vessel, but a pad of gauze should be *firmly crowded upon the opening* with complete assurance of efficient hæmostatic action. When the wound in the vein, although large, still admits of control during the operation, by external pressure, there need be no apprehension regarding the successful removal of the gauze pad without secondary bleeding at the time of making the first dressing; the external pressure causes collapse of the vessel walls at the site of the injury, where they are immediately sealed by the rapidly forming clot against both infection and hemorrhage.

The infliction of a severe wound upon the sinus in the early stages of an operation before the vessel has been sufficiently exposed to render it readily accessible, and when each attempt at continuing the operation results in renewed bleeding, must be regarded as a serious accident which complicates the procedure to a tremendous extent and may even necessitate its temporary abandonment, until after forty-eight hours or so a clot of sufficient firmness has formed to admit of completing the operation without dangerous bleeding. In fact, *when the hemorrhage is very great from the sinus injured thus early in the course of operation*, it will be a conservative step in the interest of the patient's welfare to control the bleeding by pressure and immediately discontinue the operation, *unless the surgeon is a man of great*

*skill and thoroughly competent to meet such an emergency*, and even the most finished operator will find his fertility of resource, under such circumstances, taxed to the uttermost.

Fortunately injuries of the character and extent just described are exceedingly rare, and, with a more comprehensive and exact knowledge of surgical anatomy, combined with technical proficiency which the experience and teaching of competent operators insures for the near future, will cease to occur.

The writer has often been asked, How long must the dressing which has been applied after an operation in which the sinus has been severely wounded remain undisturbed? In reply to this question it may be said that the necessity for redressing will depend upon the early or delayed manifestation or the entire absence of symptoms indicative of septic absorption. As soon as septic manifestations appear, whether during the twenty-four hours first succeeding the operation or at a later period, the dressing should be removed and the wound thoroughly cleansed with bichloride of mercury solution 1 to 4000, with hydrogen peroxide, 3 per cent., and with 85 per cent. alcohol in addition; a daily repetition of which procedure should be practiced as long as septic manifestations are present. In the absence of any systemic disturbance, the operative dressing should not be removed until the sixth day. When the wound inflicted has been only a minute puncture the dressing may be removed upon the third day.

## FAULTS OF TECHNIQUE.

The most common fault of technique observed in using the rongeur for cutting away the overhanging cortex is a disposition upon the part of the operator to employ the instrument with one hand without supporting it with the other; in consequence of which lack of support the rongeur slips and slides about on the

margins of the opening in the bone and accomplishes its task neither quickly nor thoroughly. The rongeur selected for use at any given stage of an operation should be as broad upon the beak as the size of the opening in which it is to be employed will admit. Such an instrument is steady and removes a large fragment of bone with each effort; it is expeditious and is not likely, when pressed against a crumbling and friable inner table, to penetrate it suddenly and do violence to the contents of the cranium, as a similar instrument with a narrow beak might do; it is hence safer to use.

The technique of the rongeur is displayed to the best advantage when the handle is held firmly in one hand, and the beak supported against the bone with the other; when thus manipulated it has simplified and shortened the duration of the mastoid operation more than any other single surgical appliance which we possess.

## CHAPTER XIII.

# THE REMOVAL OF THE CELLS AT THE POSTERIOR ROOT OF THE ZYGOMA.

THE REMOVAL OF THE CELLS AT THE POSTERIOR ROOT OF THE ZYGOMA AND THE SMOOTHING OFF OF THE DIPLOIC TISSUE AND SUBCORTICAL CELLS OVERLYING THE OCCIPITAL BORDER OF THE SIGMOID GROOVE, CHARACTERIZES THE EIGHTH STEP OF THE OPERATION; SEE PLATE XIV.

Several large cells are to be found at the posterior root of the zygoma just in front of and external to the antrum; these are nearly always occupied by necrotic granulations when purulent mastoiditis has existed for any length of time. The precaution of investigating this carious focus is generally disregarded and its removal habitually neglected; it is hence a frequent contributor to the already sufficiently numerous conditions productive of secondary operation.

The diploic structures in contact with the sigmoid groove and the overlying subcortical cells as far back as the posterior border of the groove should be curetted until the inner table of the skull is smooth. The rough and irregular margin of the entire opening in the mastoid process should be carefully smoothed with the rongeur and curette.

When the situation and course of the sigmoid groove has been clearly demonstrated by the removal of the diseased and softened contiguous bony structures it is the invariable practice of the writer to institute a step which so far as his knowledge serves him he believes is not customary in the technique of other operators and which serves the twofold purpose of exposing the antrum widely and of diminishing the liability to secondary operation.

The procedure thus referred to is concerned with the removal of that portion of the mastoid apophysis which is situated immediately beneath the temporal ridge, at the posterior root of the zygoma, and which lies in part external to and in front of the antrum. (See Plate XI, at the anterior angle of the suprameatal triangle.)

A narrow gouge or chisel serves admirably to cut away the firm protecting cortex which comprises the anterior angle of the suprameatal triangle and to expose several large cells which are uniformly placed in this situation and which participate with great frequency in any suppurative process which involves the mastoid beyond the boundaries of the antrum; in fact, in almost every instance of purulent mastoiditis in which this region has been investigated these cells have been found filled with granulations or already receptacles of pus; only in cases of sclerosis of the mastoid have they been found apparently healthy when the process was elsewhere the seat of inflammation.

The cone-shaped opening created by the removal of these cells contains, at its apex, which points forward and upward toward the zygoma, a large cell with firm glistening walls the recognition of which may be accepted as an indication that healthy bone has at length been reached.

No danger attaches to the performance of this step when prosecuted with ordinary care, but in the absence of reasonable

caution the inner table of the skull is very likely to be broken through and the dura exposed; the patient, however, is unlikely to suffer any detriment therefrom unless sufficient violence has been employed to cause laceration of the coverings of the brain, which should be a remote contingency except at the hands of the beginner.

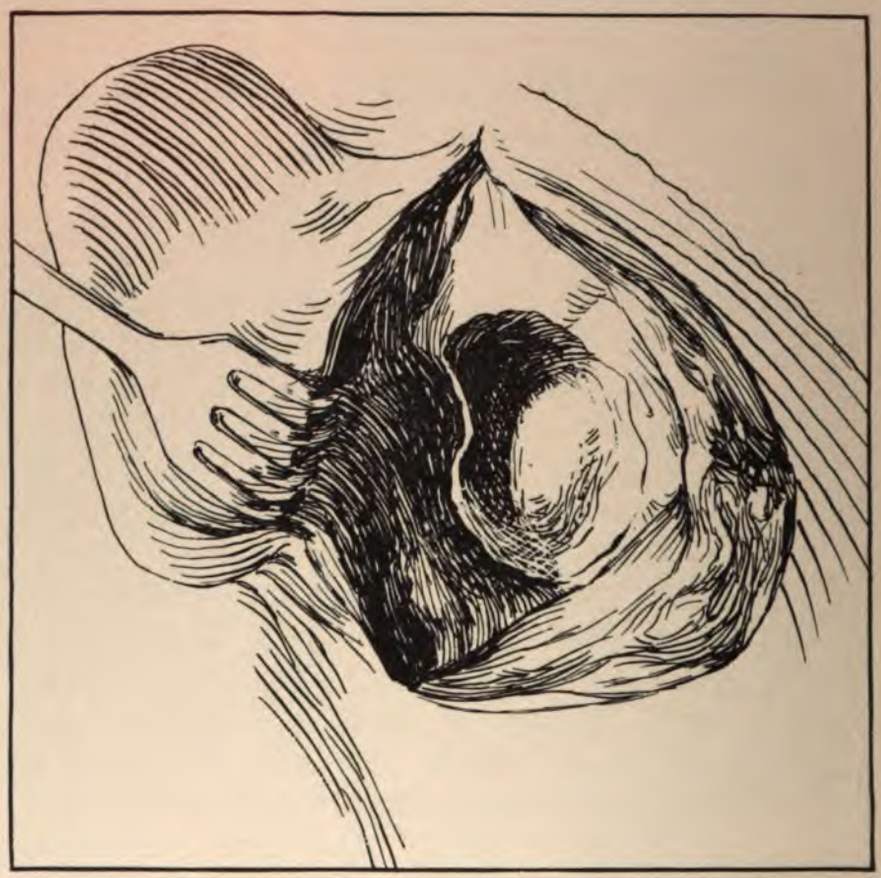
Should the inner table of the skull fracture and small fragments of bone become detached care should be exercised that all such particles are removed lest some of them, escaping observation and acting as foreign bodies, delay healing or originate inflammatory processes.

The importance of opening and exploring the recess at the root of the zygoma should not be underestimated; the author regards it as *a distinctive and essential step in the performance of the complete mastoid operation which ought never to be neglected.*

The number and size of the cells in this region vary greatly, but in most instances their combined areas represent a cavity of very respectable dimensions, while it occasionally happens (more especially in dolichocephalic skulls) that the space occupied by these cells is surprisingly large, extending as far forward as the apex of the glenoid cavity. Plate G furnishes a graphic illustration of the extraordinary extent to which these structures sometimes develop, and it will readily be appreciated that when infected they are capable of producing large quantities of pus the failure to liberate which might in a given instance be attended by much to be regretted symptoms.

The author possesses histories of five cases of suppurative mastoiditis in which purulent inflammation of these cells resulted in cortical perforation well forward in the temporal fossa, with subperiosteal accumulations of pus. In three of these cases there was also perforation of the inner table of the skull, accompanied by circumscribed pachymeningitis externa (epidural ab-

## EXPLANATORY NOTE TO PLATE XIV.



This plate demonstrates the completed second stage of the operation, all the diploic mastoid structures having been removed and the margins of the bony cavity smoothed with a curette or bur. The antrum is now continuous with the operative cavity in the bone, which has a somewhat conical outline, the apex directed toward the zygoma. The posterior flaps have been drawn somewhat forward, and are ready to be reapplied to the bone and stitched preliminary to packing the wound with gauze.

PLATE No. 14.

scess) of the middle fossa; but little pus was found in the antrum and there was practically no recognizable involvement of the mastoid process elsewhere.

*The severity of the inflammation had expended itself in and about the zygomatic cells.*

That such experience is unique there is no reason to suppose, and it is quite likely that the above recital will bring to the recollection of other observers similar extraordinary cases, the perplexities of which our present knowledge of the structural peculiarities of the temporal bone, combined with a proper appreciation of the pathological changes incident to bone inflammation, would enable us speedily to unravel.

The uniform success which has attended the complete mastoid operation since the writer began to perform it as a routine and not as an exceptional procedure, has been most gratifying and furnishes convincing proof of its effectiveness.

With the removal of this portion of the mastoid the last structures which are liable to die as the result of purulent mastoiditis disappear, and a continuous open space now exists to represent the several cavities which were formerly comprehended within the limits of the mastoid region.

The antrum is, as a result of this removal of bone, very widely opened, becoming, in fact, little more than a shallow depression or excavation.

The present moment is therefore favorable for the thorough and careful cleansing of this space from all infective material which has accumulated within it and for a critical inspection of its walls lest any softened bone escape detection.

In the experience of the writer with his own cases and with numerous others which have come under his observation in the hospital service of different colleagues he has found the majority of mastoid wounds which failed to heal within a reasonable

period and which presented pouting granulations about the orifices of fistulous tracts, to lead upon probing directly inward and forward to the situation of the cells about the boundaries of the aditus and at the root of the zygoma. In fact so forcibly was the writer impressed with the agency of this bony structure in contributing to the numerous cases of reoperation that the wisdom of its routine removal was considered and determined upon four years ago, since which time more than two hundred consecutive mastoid operations have been performed by him or by his assistants under his direct personal supervision with the necessity of reoperating in only one single instance, whereas formerly reoperations were frequent and annoying accompaniments of each winter's service. The failure to remove or oftentimes even to inspect the mastoid tip was in times but recently past a fertile source of secondary operation, but so effective has been the crusade waged against this unsurgical method that save at the hands of a few surviving irreconcilables it has ceased to exist as an obstacle and menace to prompt healing.

**The antrum is merely a large accessory tympanic space lined with mucoperiosteum and containing in its normal state nothing but air.**

The mucous membrane or mucoperiosteum serves the purposes of nourishment and protection to the bony walls which it invests; and any alteration in or addition to the legitimate contents of the antrum, during the course of an *acute purulent mastoiditis*, can only represent the product of such changes as these tissues would undergo in the progress of a *brief inflammation*. For example, we may expect in acute processes to find pus and granulations occupying the antrum; while we need be under no apprehension of encountering lardaceous or cholesteatomatous deposits, since the latter are the result of metaplastic changes which the epithelial lining of these cavities undergoes as an accompaniment of *intractable, chronic suppurative otitis only.*

The granulations which fill the antrum are continuous with similar newly formed inflammatory tissue in the aditus and tympanum; and a note of warning in this connection may prove effective in tempering the too energetic employment of the curette in their destruction.

All foreign material should be removed from the antrum; but the operator must bear in mind that *the horizontal process of the anvil extends well backward into the aditus*, in which situation it is readily accessible to a small curette; and may, as the result of injudicious pursuit of granulations, be dislocated to such an extent as to inflict serious and entirely unnecessary damage upon the function of audition.

The ease with which displacement of the anvil can be accomplished will doubtless occasion surprise to those who have given but little consideration to the subject; and the writer believes that instead of being a remote contingency or an improbable mishap, *this accident is responsible for the unaccountably poor hearing after many mastoid operations for acute conditions* the ultimate result of which is otherwise most satisfactory.

Simultaneously with the removal from the antrum of all infective material and the establishment of thorough drainage, recession of the inflammatory symptoms within the tympanum begins, and atrophy of the granulations which have invaded it should be prompt and complete. It is the part of conservative practice, therefore, to avoid all needless manipulation about the aditus, since such prospecting is unlikely to prove beneficial and may inflict unnecessary and much to be regretted injury upon the facial nerve, the remoteness of the situation of which from the necessary field of operation in *acute mastoiditis* fortunately renders its violation at the hands of a skilful operator practically unknown.

There is in the whole category of surgical experience no ac-

cident more distressing and humiliating, from the point of view either of the doctor or of the patient, than the deformity incident to facial paralysis, and a lively appreciation of this fact has exercised a wholesome restraining influence upon the ardor of many an inexperienced but enthusiastic disciple of otology who would otherwise have been disposed to assume unwarrantable risks.

To the beginner in the surgery of the ear the mere suggestion of paralyzing the face is an appalling prospect, while even the seasoned campaigner cannot contemplate such a catastrophe with any degree of equanimity; as for the sensations of the patient, it is useless to attempt to analyze them—no language can adequately express the combined mortification and disgust which the staring eye and distorted visage daily and hourly inflict upon the hapless victim of this unfortunate accident, a distress which the surgeon is by no means always justified in attempting to mitigate by the assertion that the infirmity is but temporary.

In the performance of the Stacke operation or the radical operation for chronic otorrhœa the possibility of injury to the facial nerve must always be apprehended as a by no means remote contingency notwithstanding a display of the greatest skill by the surgeon; but during the Schwartze or classical procedure *for acute mastoiditis the nerve is unavoidably endangered only under most exceptional circumstances* and any injury inflicted upon it is usually due either to carelessness or to a lack of thorough acquaintance with the surgical anatomy of the region.

The process of curetting the floor and the anterior wall of the antrum furnishes the only legitimate danger to this important structure, and the exercise of caution in the performance of this step will insure against damage, a fact which still further emphasizes the wisdom of avoiding needless manipulation about the aditus, immediately upon the anterior border of which the nerve is situated.

Should recognizable softened and discolored bone extend into the aditus it will be most safely and expeditiously removed by placing the convexity or bowl of the curette upon the floor of the antrum and scraping thence upward and outward away from the dangerous locality.

An intimate acquaintance with the surgical anatomy of the temporal bone furnishes the only reliable solution of the difficulty, for in the absence of such knowledge a multiplicity of rules and directions, instead of simplifying the procedure, will only confuse and perplex the student, **and the facial nerve will continue to prove for the future, as in the past, a menace to the venturesome and a pitfall for the unwary.**

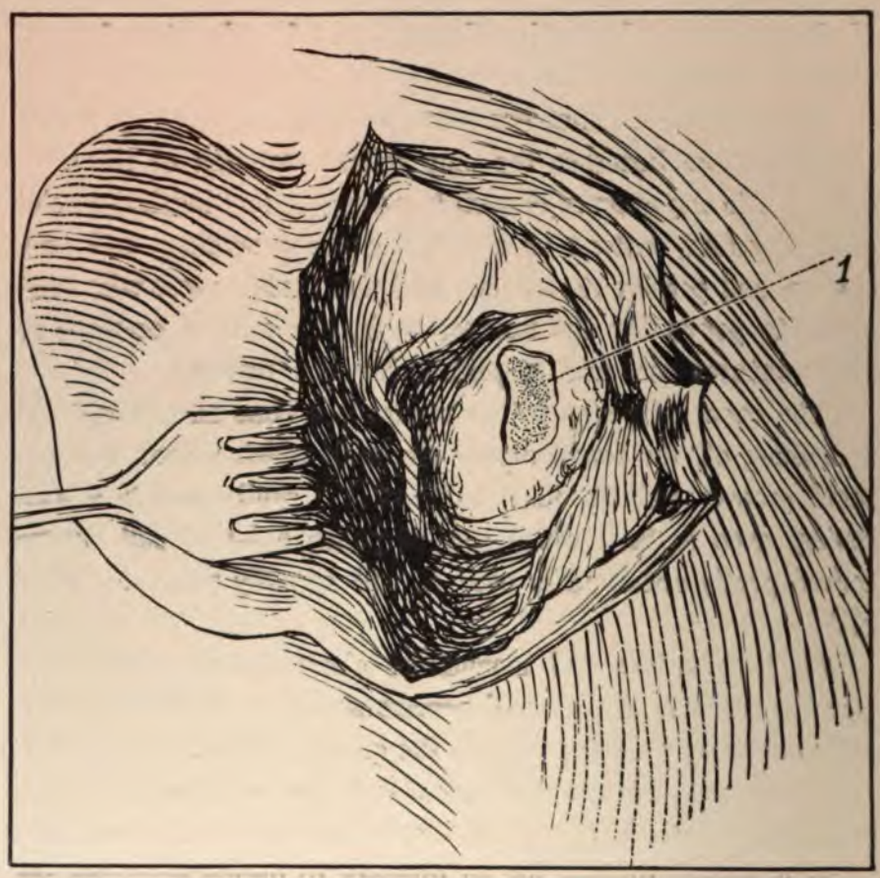
The concluding step in the removal of bone now consists in smoothing off the rough diploic structure which invests the sigmoid groove until the inner table of the skull presents a glistening, even surface, which sort of polish a large, dull curette moved gently and rapidly over it, will speedily produce. Plate XIV.

All irregularities and inequalities about the margins of the opening made in the mastoid process should be smoothed down after the manner employed upon the groove until no rough points are to be felt beneath the finger, with the satisfactory accomplishment of which the mastoid operation *per se* is completed.

It is seldom difficult for an operator to decide regarding *the vitality of cortical bone*, for its scanty blood supply enables him to scrutinize it closely and to recognize readily any deviation in color from its normal brilliant whiteness; while its well known density and brittleness offer an additional and unmistakable standard for comparison with any structural changes incident to softening and decay.

With the *cellular* structures of the mastoid, however, the condition is very different, and it is often impossible to differen-

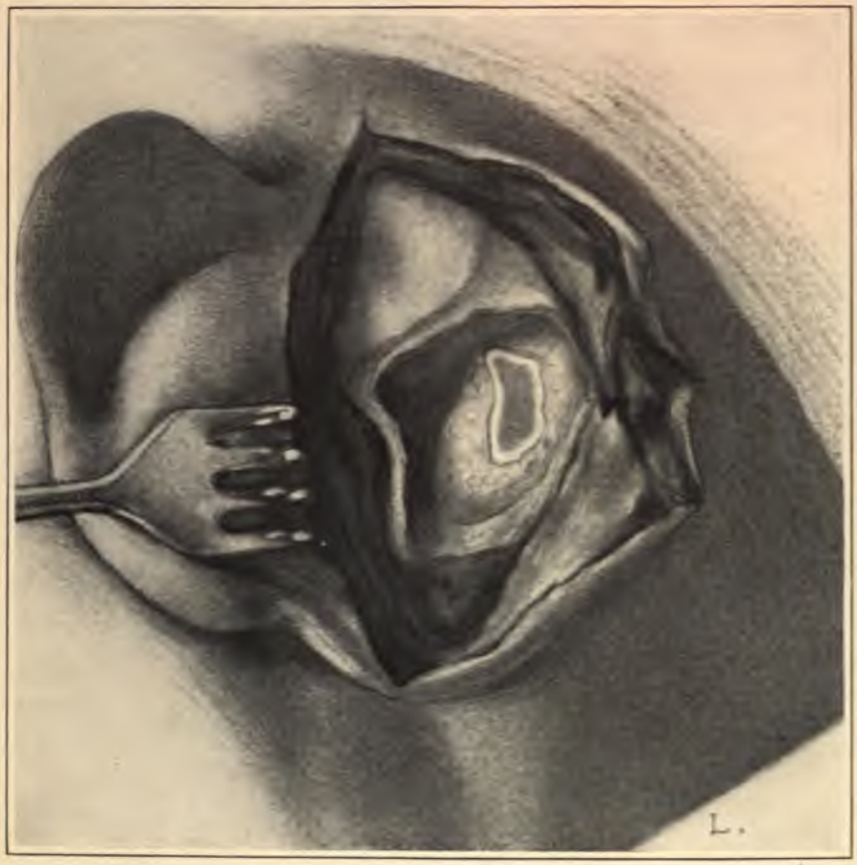
## EXPLANATORY NOTE TO PLATE XV.




This plate shows an irregularly shaped opening in the inner table of the skull arbitrarily selected along the course of the sigmoid groove, since it is in this situation that epidural inflammatory processes are most frequently encountered.

The dura presents a roughened surface upon which a thin layer of plastic material has been deposited; when the epidural inflammation is of longer duration, extensive areas may become involved, and large masses of necrotic granulations, with accumulations of pus are often found. Whenever, in the course of mastoiditis, perforation of the inner table has occurred, as the result of suppurative osteomyelitis, sufficient bone must be removed from the vicinity of the perforation to expose not only all the inflamed area but a narrow margin of healthy dura as well (1), since in no other way can an operator assure himself that the inflamed dura has been relieved of pressure.

PLATE No. 15.



tiate, as far as color is concerned, between healthy and diseased bone, owing to oozing of blood, which both obscures the field and stains the cells, rendering abortive the most critical and painstaking inspection.

The density of the cellular structures is also a vain dependence, for while the crumbling softness which precedes and accompanies disintegration of bone is readily apparent even to an unskilled operator, the finest sense of discrimination may fail in difficult cases to appreciate the difference between the hardness of those cells which are entirely healthy and the firmness of others which depart but slightly from the normal; the nutrition of which, however, is so far impaired that if not removed they will subsequently die. The macroscopic appearance of the tissue is that of health, wherein the physical signs are misleading, for molecular death has already begun.

In view of which experience an operator will be certain of his result in infective disease of the mastoid, *only when all cellular structures have been removed.*

In concluding the consideration of operative measures upon the mastoid bone a word may not be inopportune regarding the expediency of a procedure which has the indorsement of such an eminent otological authority as Buck, of New York, who has expressed himself as being in favor, after the removal of all inflamed mastoid structures, of exposing for purposes of inspection the dura of the middle and posterior cranial fossæ over a small area, even should the inner table of the skull in the above mentioned situations be, so far as could be determined, entirely healthy, and notwithstanding the fact also that no symptoms pointing to intracranial involvement are present.

The advocacy of the step is based upon the supposition that an unsuspected inflammatory process might be discovered in its incipiency and promptly relieved; whereas it would other-

tures as a matter of routine, merely because they are accessible through the open cavity of the mastoid, does not appear to the writer either conservative or good surgery and he believes that further reflection and experience will condemn the practice.

## FAULTS OF TECHNIQUE.

The most common fault of technique observed in the performance of the simple step of smoothing off the roughened cellular structures over the sigmoid groove and the irregular edges of the opening in the bone is a disposition, in which respect the beginner is the chief offender, to hold the curette too nearly vertical to the surface which is to be smoothed. The reason for this slight technical error is a failure to appreciate that the purpose and scope of the instrument have suddenly been changed, that it is no longer used to detach or drag out loosely adherent fragments of bone from a deep cavity or recess, but it has now assumed the office of a plane, for the satisfactory performance of which duties the curette should be held so that the cutting edge lies as nearly as possible horizontal with the surface which it is intended to smooth. When held in this manner and drawn rapidly and repeatedly, but without the exercise of much force, over a rough surface it is surprising how quickly all the irregularities disappear.

Surfaces which have thus been rendered smooth granulate much more rapidly and evenly and heal more quickly than do the walls of cavities which are covered with rough particles of bone, for the absorption of which the generous aid of nature must be invoked before healing is complete.

## CHAPTER XIV.

# THE CLEANSING OF THE WOUND AND THE APPROXIMATION AND STITCHING OF THE FLAPS.

THE LIGATION OF ANY VESSELS WHICH STILL BLEED, THE IRRIGATION OF THE WOUND, THE APPROXIMATION AND STITCHING OF THE FLAPS, CHARACTERIZE THE NINTH STEP OF THE OPERATION.

Should any active bleeding from the flaps persist after the completion of the operation upon the bony structures ligatures of catgut should be applied to the vessels, after which the wound should be thoroughly irrigated with a hot solution of bichloride of mercury 1 to 5000 and closely inspected for the presence of any small detached fragments of bone which might otherwise escape detection and, acting as foreign bodies, retard healing. The flaps are next carefully replaced upon the denuded bone, approximated and stitched with silkworm-gut at the extremities, the stitch passing sufficiently deeply to include the periosteum. A somewhat triangular shaped wound results from the partial stitching of the flaps, but when union is completed there remain only two linear scars nearly at right angles to one another.

As has already been indicated in the description of the incisions for the construction of the flaps, the hemorrhage encountered in the uncomplicated mastoid operation is usually insignificant, and as a rule the bleeding from the divided vessels which has been checked by means of artery clamps applied as soon as the vessels were cut is seldom reestablished upon the removal of the forceps if these instruments are unlocked with care; in some instances, however, either because the blood of the patient is deficient in fibrin and does not furnish a firmly obstructing clot, or for the reason that an unusually large artery has been divided, or owing to rough manipulation by means of which bleeding is reestablished from vessels which had ceased to bleed, it becomes necessary to apply a few ligatures of catgut; the method of such ligation differs in no respect from the same procedure elsewhere and does not demand special description.

After the cessation of active hemorrhage—the slight oozing from the flaps and bone may be disregarded, as it is of no moment—the wound should be thoroughly irrigated and cleansed with a warm solution of bichloride of mercury 1 to 5000, and caution should be observed in the performance of this step that the fluid is not forced through the open aditus into the middle ear and thence, if the tympanic membrane is not sufficiently widely open to admit of its ready escape into the external auditory meatus, through the Eustachian tube into the pharynx. This accident is a very common one and is usually attended with no serious result because the amount of bichloride thus swallowed is small; the writer once saw several ounces of sublimate solution thus forced into the pharynx, and but for the immediate recognition of the direction which the fluid had taken a serious result must have been apprehended; as it was, the patient was quickly turned upon his face, when the greater portion of the solution poured from his nose and mouth, to the great relief of the operator.

With the modern method of performing the mastoid operation but little importance need be attached to the accomplishment of the procedure which the older writers entitled "through drainage," a step which was an absolute essential of the technique of that period, since they had otherwise no means of knowing with certainty whether or not they had established communication with the middle ear, for they seldom or never removed a sufficient amount of the mastoid cortex and cells to admit of direct inspection of the aditus and tympanum, hence the necessity of forcing water by means of a syringe through the external auditory meatus and out of the small opening in the mastoid cortex was a diagnostic feature of the first importance, and a very healthy diversity of opinion existed among authors as to whether it was more desirable and advantageous to wash through from the canal and out of the bony opening in the mastoid, or whether the fluid should be forced through the opening in the bone and thence by way of the middle ear outward through the external auditory meatus; each method had its staunch advocates who deprecated the slovenly surgery of colleagues holding opposing views.

The complete mastoid operation fortunately eliminates this source of wrangling, for with its successful termination there is nothing to "wash through."

The antrum, from a deep and narrow recess with carious walls enclosing an accumulation of pus, has been converted into a shallow and wide excavation whose boundaries are firm, healthy bone and the bottom of which is continuous inward and forward with the aditus, through which short passage an intimate inspection of the tympanum is easy of accomplishment: as there is no infective material remaining upon the thoroughly healthy surface now established, about the only purpose served by irrigation is to remove all fine bony detritus which the curette often

deposits about the deeper parts of the wound and which escape detection and delay healing, and to flush away any tough stringy clots of blood which interfere with apposition of the flaps or which by their presence offend the sense of surgical neatness; the antiseptic properties of the fluid are of little moment, and hot saline solution will prove under most circumstances an adequate substitute, save in those infrequent cases in which in addition to the infective character of the inflammation offensive saprophytic properties are present as well; such processes demand the exhibition of agents possessing both antiseptic and deodorant qualities.

The operator having assured himself that the wound is clean, the flaps are now carefully reapplied to the bone and with deep sutures of silkworm-gut, care being exercised to include the periosteum, brought into firm and close apposition at the angles of the cutaneous wound, leaving about half the wound open for purposes of packing with rubber tissue and gauze, as will be subsequently described, with the intention of permitting the wound to fill by granulation, such procedure being commonly regarded as the safest course to pursue with wounds which are made for the purpose of relieving any structure of the presence of infective discharges. Various methods have been from time to time advocated with the purpose of hastening the healing of the wound and minimizing the resulting scar; these may be briefly formulated as follows:

1. Complete closure of the wound by primary suture.
2. Complete closure of the wound by secondary suture.
3. Granulation of the entire wound.
4. Closure of the angles of the wound by primary suture with granulation of the remainder.

Each of the above mentioned procedures is possessed of advantages which commend it as well as of defects which may be justly criticized.

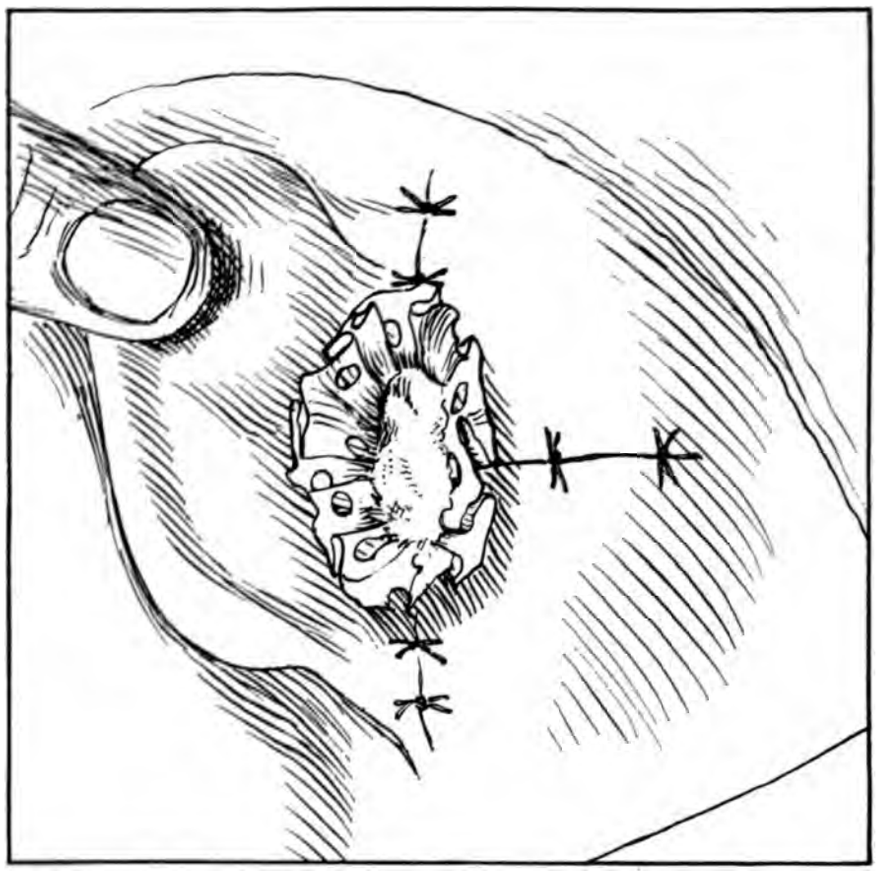
## 1. COMPLETE CLOSURE OF THE WOUND BY PRIMARY SUTURE.

Of late there has been quite a spirited agitation, by a few operators, for a revival of the method of closing the wound completely by primary sutures and permitting it to fill with a clot in the anticipation that primary union will result; that such expectation is justified in many instances the reported cases of Blake, at present the most ardent advocate of the measure, clearly indicate; the wisdom of employing such a step in every case has, however, been by no means conclusively demonstrated, and the majority of men have doubtless attained the most favorable results by combining the two methods, which is to say, to suture the extremities of the wound at the time of operation and permit the centre (that is the deepest portion) to granulate; such is the practice of the writer, and his experience has been thus far very gratifying; he therefore feels it incumbent upon him to so advise other operators, in the belief that they will find the method satisfactory.

That complete primary suturing of the wound will prove an adequate expedient in a fair proportion of operations is probable, but the indication for such procedure is limited to judiciously selected cases; such, for example, as have required the removal of but a small amount of bone, perhaps only the cortex over the situation of the antrum and the cells at the tip, the greater portion of the mastoid apophysis being still healthy.

Or, again, in children, where the process is small and the bone cavity shallow, the prospect of primary union is reasonably favorable but by no means assured. The occasional experience of septic absorption, with alarming symptoms from retained pus, constitutes a decided and warrantable objection to this measure. The nature of the infection must also play

## EXPLANATORY NOTE TO PLATE XVI.



This plate shows the coaptation of the flaps, maintained by stitches at the angles of the wound, and some gauze protruding from that portion of the wound, which it is designed shall heal by granulation. Beneath the gauze a layer of semitransparent fenestrated rubber tissue, which lines the walls of the mastoid cavity throughout is seen protruding, thus separating the gauze from the granulating surface and rendering the first dressing painless for the reason that granulations do not adhere to rubber tissue.

PLATE No. 16.

an important part in deciding upon the wisdom of primary complete suture after mastoid operation, for if the infecting agency be pure streptococcus or even of a mixed type in which that germ predominates, the expedient is foredoomed to failure, but the milder varieties of infection offer a more hopeful prospect of success.

A fair estimate of its merits leads to the conclusion that while the *complete primary suture* sometimes succeeds it more often fails, and while in the event of failure the condition may perhaps simply signify a cause for reopening the wound, introducing packing, and starting anew (just as if making the original dressing for an open wound at the time of operation), the fact must be borne in mind that it is occasionally quite a different and less gracious task, for by the time it has been decided that the wound must be reopened the flaps are infiltrated to a considerable extent by retained pus and infective discharges and are by no means in as favorable a condition for healing by granulation as at the time of operation.

In this step as in many another venture it rarely happens that the second string to one's bow is equally efficacious with the first. The author's experience with the procedure has not been satisfactory or such as would induce him to commend it to others.

## 2. COMPLETE CLOSURE OF THE WOUND BY SECONDARY SUTURE.

Closure of the wound by secondary suture is a step rarely practised in this country, nor has it any very ardent advocates in Europe at the present time.

The variety of wound which provides the required conditions for secondary suture is, as a rule, of a type with which we are quite contented to let well enough alone, inasmuch as the advantages to be derived from it are scarcely commensurate with

the degree of pain inflicted during its performance without an anesthetic.

The claims to surgical consideration upon which this expedient depends are twofold: first, that by drawing the granulating margins of the mastoid into apposition it is much diminished in size, requires but a small dressing to protect it, and admits of the substitution of some inconspicuous covering in place of the detested and uncomfortable bandage; second, that the duration of the patient's disability is materially shortened and the resulting scar rendered less unsightly.

These seemingly convincing arguments are in fact more apparent than real, for the physical appearances of a wound which characterize it as offering reasonable probabilities of successful healing by secondary suture are just such as would invariably lead us to anticipate *speedy closure by granulation* if simply encouraged by appropriate dressing, and inasmuch as the practice is exceedingly painful and shortens the convalescence but a measurable period without greatly reducing the size of the scar, and since it cannot be successfully undertaken until granulation is far advanced (at which time the diminished size of the wound already admits of discarding the unsightly bandage and substituting a silk pad or even an adhesive plaster dressing), the chief indications for its performance have already disappeared.

### 3. GRANULATION OF THE ENTIRE WOUND.

Two objections have been raised against permitting the entire wound to granulate, namely, that union is thereby delayed and that the resulting cicatrix is broader and more unsightly.

As regards the accuracy of the first assertion, that healing is delayed, it may very reasonably be questioned: for the obser-

vations of all operators will agree that the angles of the wound when not stitched at the time of operation, so far from healing slowly, are prone to close very quickly and thereby to increase the relative depth of the centre of the wound; or, to state the case inversely, the granulation of the deeper portion of the opening in the mastoid seldom or never keeps pace with the tendency of the flaps to close at the angles, a matter which is very simple of comprehension, for the deeper structures which must supply the granulations to fill the cavity are bony and of course have a much less abundant blood supply upon which to rely for the necessary nourishment and maintenance of newly generated tissue than the tremendously vascular cutaneous flaps.

So far as concerns the element of time in the healing of mastoid wounds, there is often occasion for wonder at the very great rapidity with which an extensive wound, which owing to the sloughing condition of the flaps or for other sufficient reason the surgeon has decided to leave entirely open, will fill with granulations and close. So striking, in fact, has this experience proved upon several occasions as to be worthy of careful consideration and analysis. It has appeared as if a needed impetus was imparted to the sluggish and meagre tissue production of the bone cavity by contact and coalescence with the vigorous and oftentimes luxuriant granulations of the surrounding integument, and almost before one is aware of the fact a gaping wound has filled with granulations, contracted and closed as if impelled by the charm of some magic influence.

A startling demonstration of the character just described is commonly afforded after the operation for epidural abscess, the rapidity of healing in which occurs seemingly in direct proportion to the extent of dura exposed; a fact not difficult to account for when we consider for a moment how prolific a source of granulation the dura becomes upon the least provocation and

how under the forementioned conditions the meninges are simply displaying a disposition to turn to favorable account a characteristic which has always stood them in good stead.

The slowly producing bone cavity being stimulated and encouraged by healthy and vigorous granulations both from the integument above and the dura below, is aroused to unwonted activity and healing ensues in an incredibly short time.

After each such experience the writer is almost persuaded of the desirability and applicability of this procedure to all mastoid operations, but a consideration of the second objection, namely, that the unsightliness of the cicatrix is materially increased, has dissuaded him.

That a greater amount of scar tissue is produced when the wound is permitted to granulate throughout its entire extent cannot be gainsaid, but that such a result is to be regarded as a serious affliction either from a cosmetic or pathological standpoint may not be too stoutly maintained, for keloid scars upon the mastoid are very uncommon, and as a rule the evidences of a mastoid procedure will within a few months have become unrecognizable to casual observation, or at any rate have ceased to be conspicuous.

### 4. CLOSURE OF THE ANGLES OF THE WOUND BY PRIMARY SUTURE WITH GRANULATION OF THE REMAINDER.

Taking into consideration the various agencies which combine to secure a satisfactory result in the union of mastoid wounds, namely: the duration of healing, the extent and situation of the scar, and the ultimate position of the auricle with reference to cosmetic effect, and the writer is convinced, as already stated, that the most uniformly favorable results are to be anticipated from combining the two methods of treatment;

which, briefly expressed, consists in packing with gauze the deeper part of the wound (that is, the bone cavity) and stitching the superficial portion (that is, the flaps) at the angles.

Of the methods enumerated complete closure of the wound by primary suture is of course the ideal procedure, but experience teaches us that the method is not only unreliable but may even, under exceptional circumstances, introduce into the case a needless element of gravity.

The most serviceable sutures for maintaining the apposition of the flaps, in that they can be the longest retained in position without undergoing absorption or themselves absorbing the secretions from the wound, are of silkworm-gut or chromatized catgut: either material answers admirably.

The sutures when introduced should be carried to a sufficient depth to include within their compass the integument, the muscular tissue and the periosteum.

## FAULTS OF TECHNIQUE.

The faults of technique most commonly observed in the approximation and stitching of the flaps are two in number: first, a disposition to introduce the sutures in such a manner as not to include the periosteum; second, a disregard for the exact apposition of the cutaneous margins of the flaps, resulting frequently in inversion of the edges and failure to unite.

No surgical procedure could be much more simple in its performance than the introduction of sutures in such a manner as to include the periosteum within the loop. That this important nutrient membrane often fails to be thus included is due simply to inexcusable negligence.

The same criticism may with equal justice be directed at the inattention which permits the edges of the flaps to become inverted, so that union is prevented.

Such faults of technique are exceedingly frequent, and of course are to be accounted for only on the score of disregard for those details careful attention to which constitutes precision in operating.

## CHAPTER XV.

# THE DRESSING OF THE WOUND AND THE APPLICATION OF THE BANDAGE.

THE DRESSING OF THE WOUND AND THE APPLICATION OF THE BANDAGE CHARACTERIZE THE TENTH AND LAST STEP OF THE MASTOID OPERATION.

The care of the wound necessitates the employment of an inner and outer dressing. The inner dressing consists of a lining of fenestrated rubber tissue (a strip six inches square or thereabouts, which has been rendered sterile by immersion for several hours in sublimate solution, 1 to 2000, is ample) within which strips of iodoform gauze (five per cent.) one inch in width and loosely folded are gently packed and arranged within the opening in the bone in such manner as to bring the rubber tissue in contact with the walls of the cavity throughout its extent, and so disposed as to exercise sufficient pressure to control any vascular oozing. See Plate XVI.

Upon the rubber tissue and gauze protruding from the wound the outer dressing is laid; this consists of a fluffy pad of iodoform gauze (five per cent.), over which a similar pad of sublimated gauze is placed; covering both of these

**is a thin layer of cotton, which insures the even distribution of pressure upon the auricle when the bandage is applied. See Plate XVII.**

The introduction of the rubber tissue lining within the wound is easily accomplished; a piece of rubber tissue about five inches square which has been rendered thoroughly sterile by long immersion in a solution of bichloride of mercury, 1 to 2000, and which has been fenestrated after the manner of a common porous plaster, is carefully wrapped around a little bunch of iodoform gauze placed in its centre. The rubber tissue thus assumes the shape of a sack or bag, the bottom of which is filled with gauze. The little bag is of such size as to be conveniently introduced within the orifice of the wound without undue crowding and carried by gentle pressure down into the antrum, the vicinity of which represents the deepest part of the opening in the bone; moderate pressure with a probe or other instrument will distribute the gauze in the bottom of the rubber bag in such wise as to insure equalization of pressure and smoothness of application of the rubber to the various irregularities of the bone and tegumentary flaps. The rubber is so thin and tractable as to offer no obstacle whatever to efforts at applying it evenly, although the sides of the cavity which are being lined thereby are by no means symmetrical.

The first wad of gauze which is deposited in the rubber bag serves not only to drain the deepest portion of the wound, but acts also as a kind of anchor or wedge to hold the rubber in its proper place until a sufficient number of additional strips can be successively introduced to fill the bag and maintain an even pressure upon all parts of the open wound. The introduction of the needed additional gauze is easily managed by the aid of a thin probe or other not too bulky instrument, and is most conveniently performed when the gauze has been cut into strips of

PLATE No. 17.

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about one inch—25 mm.—width and of any convenient length, such strips lending themselves with readiness to the numerous folds and plaits which close application to the boundaries of the irregular cavities of the mastoid render necessary in any dressing which may be employed. The gauze should first be thrust gently but firmly to the bottom of the wound; and upon the first folds thus inserted successive plaits should be laid until the wound is entirely filled with gauze which exercises pressure upon the surface of the rubber tissue sufficient to maintain an effectual control of bleeding from the numerous capillaries which have been divided. When the wound is filled with the gauze to such an extent that it protrudes slightly from the encircling neck of the sack, the superabundant rubber tissue is unfolded and spread out evenly in all directions upon the integument surrounding the wound. See Plate XVI.

That the inner dressing of the wound may be properly completed a sterile gauze strip should be gently inserted into the external auditory meatus and carried inward to the fundus of the canal without attempting to pack it in such manner as to cause distention or any appreciable pressure; drainage of all discharge from the canal is thus favored, and at the same time the sensitive skin of the meatus is protected as far as possible against the infective agency of any irritating secretion from the wound or tympanum.

The numerous and important modifications in the mastoid operation which the last decade has witnessed have concerned themselves chiefly if not entirely with efforts so to improve the technique as to reduce the mortality of the procedure and diminish the frequency of secondary operation, in all of which laudable endeavors the minimum amount of consideration has been expended upon any attempt at reducing the discomforts of the patient incident to dressings and other post-operative manipulation.

The one inflexible purpose has been to cure the disease, and the sensibilities of the patient, in the pursuit of this ambition, have been regarded by the medical attendant with heroic indifference. Now, while fully concurring in the precept which makes a cure the first essential, to be accomplished at all hazards, and while endorsing the method which subordinates every expedient to that end, the writer believes that it is only humane and will in nowise detract from the thoroughness of the procedure so to arrange the dressings as to reduce to the minimum the pain of post-operative treatment. There has been a disposition to regard such elegancies of practice as rather superfluous, and to consider the patient sufficiently fortunate to have recovered his health and regained the function of the affected organ without bothering one's head unduly concerning the thorny pathway over which the sufferer must approach the coveted goal.

Just as modern therapeutics has made grateful concessions to the formerly outraged but vainly protesting stomach in the interests of the patient's comfort and without prejudice to his welfare, so in like measure the sufferings of the victim of mastoid surgery may be decidedly mitigated and the discomforts of his situation materially lessened by the introduction of technical refinements which detract in nowise from the efficacy of the operation, but which are to the patient a source of inestimable relief and gratification not to be measured by ordinary standards of physical comfort, and to be appreciated at their full significance only by those who have experienced the ease of the one and the distress of the other method of procedure.

The employment of rubber tissue in dressing the mastoid wound at time of operation is not a matter of necessity, and so far as the writer is aware is used for such purpose by himself alone, although general surgeons have long since taken advantage of its flexibility and impermeability (which prevents granu-

lations from adhering to it) to facilitate dressing and aid drainage.

Any doctor who has ever officiated at the removal of gauze from the mastoid in the first dressing of the wound will testify to the severity of the pain inflicted by dragging out the tightly packed material, the resistance of which the soakage from the secretions of the wound has greatly increased.

The pain is sufficient to occasion complaint from the most stoical adult, while the torture inflicted by the procedure upon small or feeble children or babies is truly distressing to witness, the more so as it is needless, for it can be absolutely avoided by using rubber tissue after the manner just described; and in the opinion of the writer the dictates of simple humanity leave to the operator no choice but to accept this, or some equally efficient method, at once.

Rubber tissue should be removed from the wound at the expiration of twenty-four hours, in order that no undue blanching of the tissues from the heat of the rubber may ensue. In the removal of the dressing the comfort of the patient will be insured by the precaution of lifting out with forceps the gauze contents of the rubber bag, and then extracting the rubber tissue, rather than by dragging the rubber sack with its contained packing *en masse* from the wound.

There is but one contraindication to the use of rubber tissue for mastoid dressing, and that is found in the presence of severe venous hemorrhage, such, for example, as is afforded by injury to a large emissary vein or to the sigmoid sinus; under such circumstances direct pressure is more advantageously maintained and greater hemostatic effect insured by immediate contact of the gauze with the bleeding point.

## THE OUTER DRESSING.

The outer dressing consists first of a fluffy pad of iodoform gauze, so disposed as to completely cover and protect not only the wound but the post-mastoid and parietal regions as well. It should be so moulded to its position that it will fit closely beneath the posterior surface of the auricle which is to be comfortably supported by it, an essential detail and not to be neglected in the preparation of a dressing which it is designed to subject to firm pressure for a period of twenty-four hours.

A second similar pad of iodoform gauze is now laid upon the anterior surface of the auricle, being sufficiently large to completely cover that member and to extend backward and overlap the greater portion of the first pad.

A third pad of sublimated or sterile gauze, thinner than the first two but comprehensive enough to cover them both, is now placed in position, and over all a thin blanket of absorbent cotton is spread, which last material serves the double purpose of presenting a surface to which a bandage readily clings without slipping, and also by its elasticity contributes to an even distribution of the bandage pressure upon the auricle and all the surrounding cranial area which has been subjected to operative manipulation.

A bandage of thin muslin or heavy cheesecloth, two inches in width and six yards in length, will be found serviceable, comfortable, and in every way satisfactory. The objects sought after in the application of the bandage are the maintenance of the dressing in position, the support of the auricle, and the control of oozing. The bandage is most conveniently and expeditiously applied in the following manner:

Unroll a few inches of whatever material is employed and hold it firmly upon the centre of the forehead, thence wind the

roll around the brow and the side of the head corresponding to the operated ear but just above, thence encircle the occiput and the temples of the opposite side in such manner as to leave the healthy ear uncovered, and carry the bandage around the brow, thus completing one turn entirely around the head; a second turn should be made in the same manner; the third turn should begin in the same way but should pass downward over the dressing at about the middle of the auricle, thence around the nape of the neck and up over the temples of the unoperated side as before; each succeeding turn of the bandage is so applied as to include an additional part of the dressing beneath its fold until the whole is evenly supported by the overlapping coils. The end of the bandage is securely fastened by a safety-pin. See Plate XVII.

However great the care observed in the application of the bandage it is oftentimes quite impossible in the case of restless infants and unruly children, notwithstanding the diligent attention of a competent nurse, to prevent it becoming displaced; such an accident, while seldom a matter of serious import in the ordinary mastoid operation, may assume features of gravity in any case in which the inner table of the skull has been removed and the brain exposed; under such conditions the soiled fingers of a child thrust beneath the dressings and into the wound may convey infection, the introduction of which it is most important to prevent.

Whenever the operator has reason to suppose, either from the age or the recognized fractious disposition of the child, that the bandage will be disarranged before the next visit, he should forestall any possible meddlesome interference by enveloping the bandage already in place with a starch bandage of gauze which has been moistened sufficiently to admit of applying its turns very accurately and closely to the head.

Such a dressing when dry is practically immovable and defies any effort which a child can exert to disarrange it. When a starched bandage is not at hand a baby's cap of thin material, with strings to tie under the chin, may be employed as a substitute.

The application of a wet starched bandage is not attended with discomfort or annoyance to the patient for the reason that the dressing first applied protects the skin from moisture during the few moments necessary for the starch to dry.

Rubber tissue is advantageous for the operative dressing only and will not be required in the subsequent care of the wound. At the first dressing, that the walls of the mastoid cavity may produce prompt and prolific granulations, sufficient Peruvian balsam is poured into the wound to anoint the surface thoroughly, after which a single wick of iodoform gauze is carried to the bottom of the wound (the former situation of the antrum) in such manner as to lie in contact with, but to exercise no pressure upon, the bone; sufficient additional iodoform gauze is then introduced to fill the whole bone cavity loosely and to maintain separation of the cutaneous margins of the incision, lest healing at the surface outstrip the slower reparative process in the depths of the wound and lead to a deep fistulous tract which prolongs the treatment in every instance and occasionally proves entirely intractable.

This dressing should remain undisturbed for three days (unless pain, temperature, or other unfavorable manifestation demands its earlier removal), when the procedure of removal should be quite painless, unless a needless amount of gauze has been firmly packed into the wound. The outer dressing is the same as at the time of operation.

With a repetition of the steps just described at intervals of three days and with the observance of proper antiseptic pre-

cautions, the progress of the case should be satisfactory and the recovery prompt and uneventful.

## FAULTS OF TECHNIQUE.

The faults of technique commonly observed in the introduction of rubber tissue and gauze in the wound, and in the application of the bandage for the purpose of supporting the external dressing about the ear, are such as concern the comfort of the patient only.

Some operators expose themselves to criticism because of the employment of unnecessary force in crowding the gauze dressing into the cavity of the mastoid; nothing is gained by needless pressure, while great and gratuitous discomfort is inflicted upon the patient.

In the application of a bandage to firmly and comfortably support the dressings about the ear, the essential feature is to place two turns entirely around the head before attempting to include the ear; the remaining turns will suffice to prevent the dressings slipping about and aggravating the already sufficient discomfort of the patient.

Plate XVII shows the proper method of applying a firm and comfortable bandage over the gauze and cotton dressings in such manner that the patient can repose comfortably in bed, and so disposed as not to interfere with mastication. A bandage applied over the vertex and beneath the jaws may be efficient, but is distressingly uncomfortable.

## THE POST-OPERATIVE CARE OF THE MASTOID WOUND.

On the subject of the post-operative treatment of mastoid wounds otological literature appears to be absolutely barren, presumably for the reason that the question has not been considered of sufficient importance to warrant any experienced observer in publishing his methods of procedure. In a monograph of the character of this work, which is designed to afford explicit instruction to the beginner in each detail of the procedure, a discussion of the management of a mastoid case subsequent to the operation may not be inopportune and may perhaps serve to relieve the perplexities of some anxious and worried doctor who is obliged to depend for his knowledge of surgical conditions upon such experience only as a limited private practice may afford.

It is quite true that an uncomplicated operation for mastoiditis does not require in its after-treatment, at the hands of the attending surgeon, a display either of special manual dexterity or of profound surgical knowledge; the problem submitted is

very simple and its solution is chiefly comprehended in the single word—cleanliness! It is, however, equally true that complications may arise during the performance of the mastoid operation—sometimes owing to lack of skill on the part of the operator and at other times in spite of superlative skill, and in still other instances because of the inroads of disease—which will demand in the post-operative care of the wound an exhibition of sound surgical judgment.

## WHEN SHOULD THE WOUND BE DRESSED?

How soon after an uncomplicated mastoid operation, which has progressed to an uneventful conclusion, should the first dressing be made?

The answer to this question will depend upon whether or not the operator has employed rubber tissue for lining the walls of the wound at the operative dressing. When rubber tissue has been used it is desirable to make the first dressing within twenty-four to thirty-six hours for the reason that the closely applied rubber tissue seems to exercise a kind of blanching or devascularizing influence upon the tissues (bone as well as muscular tissue and integument) with which it comes in contact if it is permitted to remain for a much longer period. In the beginning of his experience with the employment of rubber tissue it was the custom of the writer frequently to leave the dressing in place for three or four days, and apart from the decided blanching of the structures with which it had been in contact, he has never been able to recognize that it exercised any unfavorable influence upon the growth and development of tissue-producing granulations or upon the course and duration of healing. The question then naturally arises, if the presence of the tissue does no harm, why disturb it until the third day? To

which inquiry reply may be made that as much benefit is derived from its use in twenty-four as in seventy-two hours.

Rubber tissue is employed in the operative dressing for the sole purpose of mitigating the suffering of the patient at the first post-operative dressing, the pain of which is, under ordinary circumstances, very severe.

To what is the great pain in the first dressing attributable? Several factors combine to inflict acute pain at the first dressing.

The gauze with which the wound has been lightly filled at the time of operation becomes after a few hours tightly packed in the bone cavity owing to soakage and pressure. In making the flaps at the time of operation numerous vessels of the integument, muscular tissue and periosteum, are divided, from the severed ends of which during the few hours first succeeding operation there is a copious oozing of sero-sanguinolent fluid which moistens all the dressings immediately in contact with the wound and which thoroughly saturates the gauze owing to its special porous and absorbent qualities.

This disposition of the wet gauze to pack in the wound opening is greatly favored by the pressure of a firm bandage transmitted to it through superposed layers of moist cotton and gauze, under the influence of which it becomes firmly moulded into all the irregularities and inequalities of the bone cavity.

An additional element of discomfort appears when the operative dressing remains in place for three days before being changed; by that time granulations have begun to spring from the bone and incorporate themselves in the mesh of the gauze, to which they adhere tightly. In removing the gauze from the wound these granulations are lacerated and severe pain is inflicted upon the patient.

The employment of rubber tissue entirely obviates this diffi-

although it does not prevent the gauze becoming soaked with pus in the bone cavity it does prevent it adhering to the bone and does not permit granulations to grow into its meshes, for rubber tissue is impervious to their efforts.

Rubber tissue accomplishes as much when used for twenty-four hours as if permitted to remain in position a much longer period, for the reason that at the end of twenty-four hours the wound has almost ceased to produce the serous discharge which is largely responsible for the soakage and packing of the gauze, hence in the succeeding dressings the gauze if properly introduced in the wound should be readily and painlessly removed.

How soon after an uncomplicated mastoid operation which has progressed to an uneventful conclusion, but in which rubber tissue has not been employed in the operative dressing, should the first dressing be made?

Under ordinary circumstances the first dressing should be made seventy-two hours after operation.

What benefit may we reasonably expect to derive by waiting a certain length of time and why should we not delay still longer? Should no unfavorable symptoms manifest themselves it is of advantage to postpone the first dressing until seventy-two hours have elapsed for the reason that the stitches which were used to hold the flaps in position will by that time have accomplished their full purpose and may as well be removed. When sutures are employed after a mastoid operation for holding in contact the margins of the flaps over an infected bone cavity either silkworm-gut or chromatized catgut should be employed, inasmuch as neither of these materials will absorb any secretion from the wound and are hence much less likely to cause stitch abscess than sutures of silk. When for any reason silk is used as a suture, it should be inspected

not less than forty-eight hours after its introduction, and if any evidence of redness or swelling around the stitch is seen it will be advisable to remove it at once. If there are no noticeable indications of inflammation present the sutures need not be disturbed until seventy-two hours have elapsed.

An additional reason for delaying the first dressing for three days is furnished by the hope that the flaps will by that time have united sufficiently firmly to admit of removing the gauze packing without danger of breaking open the recently healed angles of the wound. It is very important that the union of the wound should be firm before any attempt is made to extract gauze packing from its interior because the gauze seldom pulls smoothly forth, but is likely to kink or knot and in that way cause distention and separation of the recently healed margins of the flaps.

It is unwise to defer the first dressing longer than seventy-two hours, because by that time granulations will have begun to spring from the bone and incorporate themselves in the mesh of the gauze packing; if the dressing therefore be delayed beyond the expiration of that time laceration of the granulations will ensue and there will be added an unnecessary increment of discomfort to the already sufficiently painful procedure.

The writer has known surgeons to advocate leaving the gauze dressing in the wound for a protracted period (say ten days) in the expectation that granulations springing from the bone will gradually accumulate beneath the gauze and by their own growth slowly expel it from the depths of the mastoid cavity. In a clean wound of the soft tissues such a result might be realized, but the author's experience with mastoid surgery would indicate that gauze dressing introduced within a deep bone cavity usually moulds itself to the inequalities and irregularities of the space and becomes more firmly adherent with each succeeding day

of its occupancy; the longer it remains, therefore, the more severe the pain incident to its removal.

WHAT MANIFESTATIONS OF HEMORRHAGE, PAIN, TEMPERATURE OR OTHER UNFAVORABLE SURGICAL CONDITION, MAY ARISE TO MODIFY THE RULE CONCERNING THE INTERVAL WHICH SHOULD ELAPSE BETWEEN THE OPERATION AND THE FIRST DRESSING?

### HEMORRHAGE.

1. Requiring that the bandage be reinforced.
2. Sufficiently copious to necessitate redressing the wound.

The occurrence of hemorrhage during or after a mastoid operation, sufficiently copious to endanger life, would supervene only upon a severe injury to the sigmoid sinus or an extensive laceration of a large emissary vein. When, therefore, the operation has proceeded to its conclusion without any such complicating accident, the operator need burden his mind with no fears as to his patient's welfare from that source at least.

It is, however, a very common experience to find upon examining the dressings a few hours after the operation that they are discolored by sero-sanguinolent oozing, or even that a bright red blood spot an inch or more in diameter has made its appearance upon the bandage over the situation of the wound.

Such bleeding should occasion no concern and does not demand removal of the dressings; it simply requires that a heavy pad of gauze be laid over the soiled dressing for the purpose of reinforcing it and that increased pressure be applied by an additional bandage.

An exceedingly rare experience after an uncomplicated mastoid operation is the occurrence of hemorrhage sufficiently copious to soak through the dressings and ooze beneath the ban-

dage, trickling down upon the neck in a tiny stream. Such bleeding could be accounted for only on the assumption that an unusually large branch of the post-auricular artery had escaped the notice of the operator, while ligating the vessels divided in making the incisions, and had subsequently started bleeding vigorously as a result of some severe physical effort upon the part of the patient, like retching or vomiting. Or such hemorrhage might be the result—an extremely improbable proposition, however—of having unwittingly operated upon a hæmophilian.

Whatever the cause of such active bleeding may be, it will begin within twenty-four hours of the operation, if it occurs at all, and will constitute an imperative demand upon the medical attendant to remove the dressing at once, find the bleeding points, and control them by ligature or by properly applied gauze pressure, whichever may prove the more expedient procedure in that particular instance.

### PAIN.

In comparison with the amount of traumatism inflicted, during the performance of the mastoid operation, upon the scalp, the temporal bone, and its investing periosteum, the pain subsequent to awakening from the anæsthetic is generally exceedingly moderate and only under very exceptional circumstances severe.

So uniformly is this experience true that consistent and repeated complaint of pain by a patient occurring a few hours after operation should lead to an early and careful examination of the position of the auricle and the condition of the flaps. The exposure of the auricle will sometimes find that member sharply bent or folded upon itself, as a result of unequal distribution of bandage pressure, in such manner as to press upon the sensitive margins of the wound; correction of this malposition may afford the patient the needed relief.

When the operator has assured himself that pressure upon the auricle is not responsible for the patient's pain, which has appeared too promptly after operation to be attributed to wound infection, he may order a dose of codia gr. ¼, and if necessary repeat it in two hours in case he is treating an adult; if the patient is a child a dose of paregoric will meet the requirements of the situation; but in the event of the pain persisting for thirty-six hours in spite of the administration of such remedies he should desist from the further use of anodynes, lest by their employment he unwittingly obscure important symptoms and thus interfere with a prompt recognition of some impending inflammatory process of a serious nature.

The most frequent cause of pain which manifests itself within forty-eight hours after the performance of the mastoid operation is infection of the wound resulting in more or less extensive infiltration of the flaps either at the margins or at the points of introduction of the sutures. The accompanying swelling will cause the sutures to compress the sensory nerves of the inflamed skin, thereby inflicting severe pain; unless the constriction of the swollen tissues is promptly relieved by removing the sutures a series of stitch abscesses may be apprehended which will contribute still further to the discomfort of the patient and to the area of infected tissue.

Infection of the wound is not an infrequent accompaniment of the mastoid operation, for the reason that it is exceedingly difficult when operating in the presence of purulent discharges to prevent some of the pus coming in contact with the margins of the flaps or other absorbing surfaces and causing trouble.

So well is this fact understood that when a patient complains of acute pain within twenty-four to forty-eight hours after operation we may in the majority of circumstances expect to find an infected wound or a series of stitch abscesses. Pain should not

be confused with stiffness and soreness of the neck, due to separation of the sterno-mastoid muscle from the tip of the process, of which most patients complain upon every attempt to move the head and shoulders during the first two or three days succeeding the operation; pain as a symptom of an infected wound must be present quite independent of any effort upon the part of the patient to move the body.

An occasional inflammatory manifestation which accompanies the after-treatment of the mastoid wound and the appearance of which will cause pain and necessitate an early change of the dressing, is cervical cellulitis. Cellular inflammation of the neck when it occurs in connection with a mastoid wound usually involves only a small area around the inferior angle of the incision.

The recognition of this condition should be attended with no difficulty whatever, for there will be visible redness and swelling at the affected point and a sense of brawn and resistance will be imparted to the finger upon palpation; moreover, the patient's complaints regarding the location of the pain and the restricted movements of the head, with a disposition to bend the neck toward the affected side in an effort to diminish tension upon the inflamed structures, will supply all the corroborative testimony needed.

A cellular inflammation of the neck may or may not be accompanied by a similar infection of the flaps of the wound.

When in connection with cervical cellulitis the flaps are simultaneously infected, all sutures should be at once removed, the whole wound opened wide, irrigated with hot bichloride of mercury solution, and gently packed with gauze soaked in hydrogen peroxide 3 per cent.

When the flaps show no evidence of participating in the infective process the stitches need only be removed from their lower half in order that the corresponding portion of the wound may

be opened widely, the infected part irrigated and gently packed with gauze wet with hydrogen peroxide.

In many instances this treatment repeated daily will suffice to dissipate the trouble in a few days; in such cases while the resulting scar is slightly more noticeable, it is in no sense a deformity, and the progress of the healing process is not delayed, because the wound in the soft tissues will unite long before the bone cavity can fill with granulations and close. There are unfortunately occasional cases in which infection of a very severe type extends beneath the deep fascia of the neck and causes suppuration in a situation some little distance below the extremity of the incision; pressure made upon the muscles of the neck from below upward causes pus to well up from the indurated tissue at the lower angle of the wound. The method of treatment already advised is quite inadequate for this class of cases, for the cure of which an incision must be made beginning at the inferior extremity of the mastoid wound and extending thence downward through the swollen and infiltrated tissues of the neck. When the abscess has been thus thoroughly opened it should be subjected to daily treatment of the kind described above until the swelling and soreness disappear, when it can be dressed as if it were simply an extension of the original mastoid wound, which it has virtually become. Such an extensive incision will not retard the course of healing, although it of course results in a conspicuous scar, which is to be regretted but cannot be avoided.

When careful inspection of the auricle, flaps, and neck immediately beneath the ear fails to reveal any adequate cause for pain the complaints of which we are convinced are sincere, and when the removal of the packing and thorough irrigation with hot sublimate solution does not dissipate it, we must be apprehensive that an inflammatory intracranial process is in prog-

ress (a meningeal inflammation probably) and be on the watch for the appearance of a group of symptoms which shall corroborate the suspicion.

### TEMPERATURE.

Sudden changes of temperature, even when extreme, if unaccompanied by any other manifestations referable to an unsatisfactory condition of the wound, do not constitute an urgent indication for early removal of the dressing after operation. When within a few hours after a supposed uncomplicated and thorough mastoid operation a pronounced exacerbation of temperature occurs, the responsible agent for such sudden elevation need not be expected to reveal itself upon inspection of the recently made wound; the removal of the dressings would under such circumstances be precautionary merely and in all likelihood quite useless, for the cause of the alarming manifestation, which might vary in the degree of its significance from a serious intracranial infection to an unimportant digestive disorder, would not in any event be recognizable upon the most penetrating scrutiny of the wound.

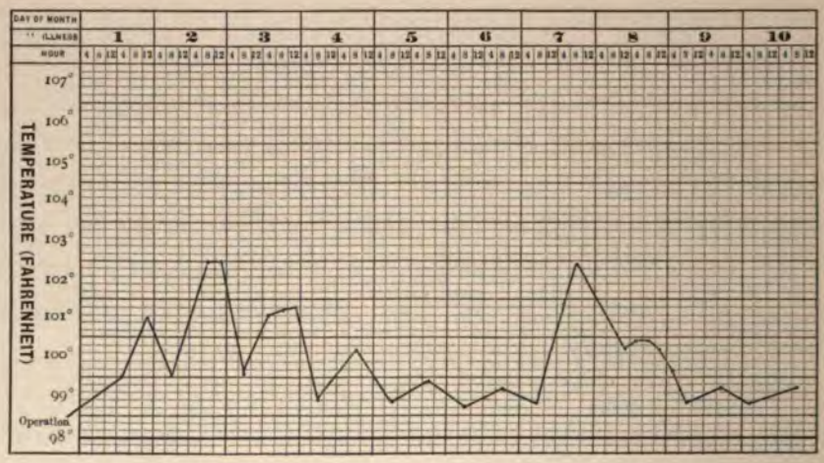
There are indeed certain contingencies which we encounter in connection with the mastoid operation in which we expect a sharp and prompt rise in temperature but which we do not regard with concern or consider as constituting an indication for disturbing the dressing.

For example, in infants and young children, including those of ten years of age, we always expect, even when we have performed an operation in which the bone cavity has been thoroughly cleaned and when previous observation of the patient has convinced us that the local inflammation is the only diseased condition with which we have to contend, a sharp rise in temperature on the night of the operation with a moderate remis-

sion the next morning. The evening of the second day witnesses a still higher rise with a proportionate decline upon the following morning.

With each succeeding day thereafter the mean temperature is lower, showing slight morning and evening variations until normal relations are established about the fifth day, and if uncomplicated by inflammatory extension or digestive disorder, maintained until the wound is healed.

CHART No. 1. ORDINARY CHILD'S TEMPERATURE AFTER UNCOMPLICATED MASTOID OPERATION.




Temperature Chart No. 1 here appended presents a characteristic exhibit of the conditions above described and may be regarded as a fair sample of the temperatures which children are apt to experience after mastoid operation.

**Analysis of Chart No. 1.**

Patient five years of age operated upon at 4 p.m., temperature 100° F., for an uncomplicated mastoiditis; operation concluded without accident; bone thoroughly cleaned. On even-

ing of operation usual moderate elevation of temperature to 101.6°, with gradual recession during night to 100° at 8 a.m. of second day. Sharper rise during second day to 103° with subsequent decline to 100.2° at 8 a.m. of third day. Thereafter moderate morning and evening variations of temperature until the fifth day, when it became practically normal rectal temperature 99.4° to 99.8°. With each increase of temperature there is a corresponding slight acceleration of the rate of pulse and respiration. On seventh day temperature rises again quickly, owing to some digestive disorder, to 103°, and under administration of calomel and soda subsides promptly and again resumes normal temperature limits.

When the temperature chart of an adult who has been operated upon for a simple mastoid inflammation exhibits any pronounced or sudden elevation during the course of healing, such departure from normal relations almost certainly announces the onset of some serious complicating lesion; in other words, the chart is not likely to show any decided increase in temperature merely as a result of some digestive disorder, bilious attack, or similarly unimportant condition, in which respect the symptomatology of mastoiditis in adults furnishes a decided contrast with the same manifestations in children, in whom almost any insignificant local disturbance will induce pronounced and rapid elevations of temperature.

Temperature Chart No. 2 (page 250) is quite characteristic of the usual temperature in mastoiditis in adults after an uncomplicated and thorough operation has been performed.

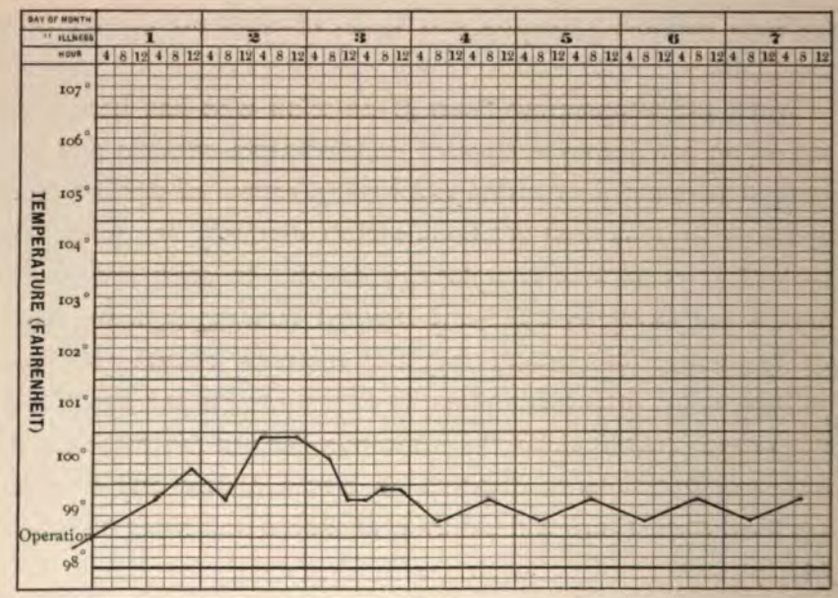
**Analysis of Chart No. 2.**

An adult patient operated upon at 4 p.m. for uncomplicated mastoiditis, temperature 99.8°. On the evening of the operation moderate rise of temperature to 100.4° followed by recession

to 99.8° at 8 a.m. of second day. Rise to 100.8° on evening of second day and thereafter gradual decline to normal rectal temperature on the fourth day with uneventful convalescence. There is the customary slight acceleration of the pulse and respiration corresponding with each increase of temperature.

The temperature waves recorded upon charts No. 1 and No. 2 are such as should occasion the medical attendant no concern,

CHART No. 2. ORDINARY ADULT TEMPERATURE AFTER UNCOMPLICATED MASTOID OPERATION.




for they are characteristic of what is commonly regarded as uneventful convalescence.

Not so, however, with the picture presented by Chart No. 3, whose startling exacerbations and remissions associated with a high average temperature for each twenty-four hours must be regarded with grave apprehension in any event, whether the manifestation concern a child or an adult. When on the first,

second, and third days, following a supposed simple mastoid operation, the temperature wave corresponds with that shown in Chart No. 3, it will be conclusive evidence that the case was not, as supposed, an uncomplicated one, but was of such a nature as to demand that a further and more extensive surgical procedure be immediately instituted for its relief, inasmuch as the operation already performed has manifestly failed to remedy the difficulty; the source of infection has never been eliminated. In similar manner it may happen that the progress of a case will be entirely satisfactory for a variable period, say ten days, after operation, when suddenly the temperature for no assignable reason exhibits a series of startling exacerbations and remissions, accompanied by one or more chills, such as Chart No. 3 so graphically depicts.

The significance of such an exceptional experience would be either that an entirely new infective process, to which the patient had fallen a prey, had been instituted, or more probably that some isolated focus of the original infection, until then inert, had suddenly been liberated in a situation favorable to rapid absorption.

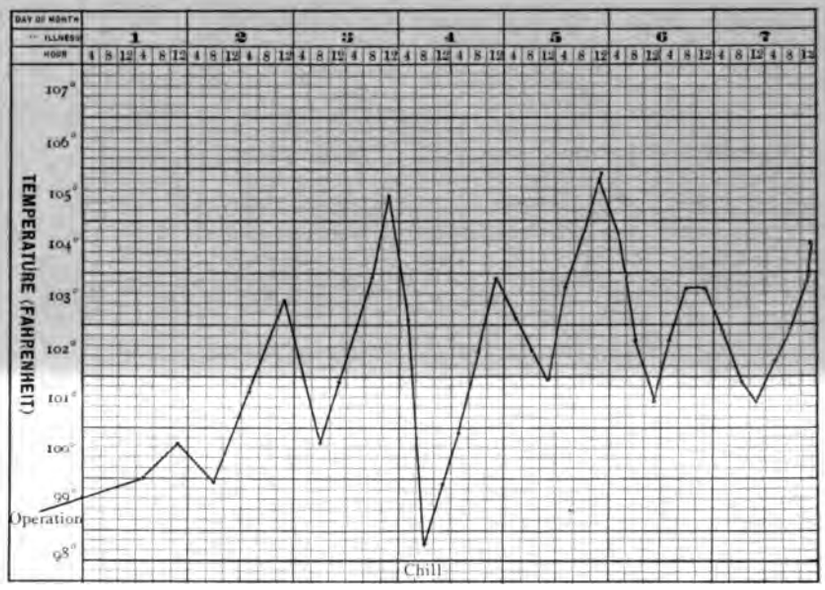
Whatever the cause of the temperature phenomena may be, the obligation which its recognition imposes upon the medical attendant should be clearly comprehended; he must undertake further operative investigation.

Temperature Chart No. 3 (page 252) exhibits the characteristic manifestations of acute and severe sepsis. Such sudden and pronounced exacerbations and remissions would be forcibly suggestive of infection of one of the large blood vessels situated in the immediate vicinity of the mastoid process, probably a sinus of the dura mater, and presumably the sigmoid sinus.

**Analysis of Chart No. 3.**

Patient operated upon at 4 p.m. for supposed uncomplicated mastoiditis. Temperature 100°; slight evening rise to 100.6°. Recession on morning following operation to 99.8°, followed by sharp afternoon and evening rise to 103.6°, falling again to 100.6° on morning of third day. A sudden shoot now develops, reach-

CHART No. 3. CHARACTERISTIC MANIFESTATIONS OF ACUTE SEPSIS.




ing 105.6° at midnight, from which the temperature drops precipitously to 98.6°, accompanied by a chill at 8 a.m. of fourth day. Thereafter the chart is characterized by abrupt and wide fluctuations, none of which approach the meridian of normal temperature, the daily average remaining high. The rate of pulse and respiration will show acceleration corresponding to the exacerbation of temperature.

### FOUL ODOR.

The presence of a foul odor about the wound is reason for immediate removal of the dressings, not so much because of the danger of infection, for many of the saprophytic bacilli are quite harmless, but because such a condition is offensive to the patient and antagonistic to all notions of either domestic or surgical cleanliness.

As soon as a foul odor is detected upon the dressings they should be removed and the mastoid wound together with the external auditory meatus thoroughly irrigated with a warm deodorant solution,—permanganate of potash, for example,—followed by the application of some sterilizing agent like hydrogen peroxide. Such treatment should be repeated daily until all fetor has disappeared from the wound and its secretions, after which dressings at intervals of three days will suffice.

### DURAL EXPOSURE.

The writer has often been asked if the exposure of the dura during the mastoid operation should be regarded as a serious complication, and if such exposure necessitated earlier dressing of the wound than would be required when the inner table had remained inviolate. To which interrogation a negative response may be returned. An exposure of the dura, when not complicated by laceration of that membrane, adds no material element of danger to the risks of operation and demands neither more careful nor more frequent dressings. The dura, contrary to the commonly accepted notion, is a membrane which is exceedingly tolerant of manipulation, and when handled under proper antiseptic conditions is not liable to give rise to any alarming symptoms. When the dura has been exposed over a considerable area for the purpose of denuding it of necrotic granulations which

have been formed in the course of an epidural inflammation it should always be flushed with alcohol (the ordinary commercial product ninety-five per cent.) in order to insure a sterile field upon which to place the dressing.

The presence of facial paralysis should exert no modifying influence upon the duration of the interval which is to elapse between dressings, for the operator need not hope to diminish the present deformity or hasten the resumption of function of the damaged nerve by any such useless expedient.

There are perhaps other conditions which occasionally arise and which might be mentioned, necessitating an early removal of the dressings, but they are not sufficiently numerous and do not recur with sufficient regularity to make a tedious enumeration of them desirable; they will be found upon reflection to be concerned for the most part with the neatness of the patient's appearance rather than essential to health and comfort.

It will be found expedient as a grateful concession to the patient's sensibilities to renew *the outer dressing every day*, the gauze packing within the wound and the gauze immediately covering the flaps not being disturbed. It is the customary practice of the writer to renew the outer dressings of adult mastoid patients each morning, inasmuch as such change is refreshing and adds materially to the tidiness or presentableness of the patient, a condition not to be lightly disregarded when ladies are concerned. With infants and small children who are restless and with difficulty controlled it will be more judicious from the standpoint of the doctor's convenience and safer with consideration for the welfare of the patient and the maintenance of cleanliness of the wound to reinforce the ordinary muslin bandage with a gauze starch bandage at the time of operation, and to leave such dressing undisturbed for three days unless some unforeseen contingency should arise demanding its earlier removal.

### Wounds of Sinus.

A question frequently asked by beginners is, How soon after an operation in which the sinus has been wounded should the dressing be renewed? The answer to this question will depend materially upon the character of the wound inflicted. If the sinus wall has simply sustained a small puncture the accident need not be taken into consideration in determining the interval to elapse between the operation and first dressing. But if a large tear has been inflicted upon the sinus wall the first dressing should be deferred until at least four, and if possible six, days have elapsed. The object of postponing the dressing is in order that the obstructing clot may become so forcibly adherent to the margins of the wound that the removal of the gauze pressure pad may not detach it and cause renewed bleeding.

An operator will know whether or not it is safe to leave the operative dressing in place for six days by the presence or absence of septic manifestations. With the appearance of the first evidences of sepsis the dressings should be immediately removed and the wound cleansed with sublimate solution 1 in 5000 and then flushed with alcohol.

### How Should the Mastoid Dressing be Made?

There is unfortunately a disposition prevalent among operators to disregard the importance of antiseptic precautions in preparing both the patient and themselves for the post-operative dressings of mastoiditis. The same surgeon who is punctilious to a degree in his attention to antiseptic requirements in preparation for an operation is in many instances sadly remiss and unwarrantably neglectful of the primany essentials of surgical cleanliness during the weary weeks of frequent dressings and attendant irksome details which the intelligent care of mas-

toid cases requires. But dressings and bedside attentions must ever lack the excitement and fascination of the operating room, and the case which has already been operated upon seldom arouses the same enthusiastic solicitude as is expended upon the case which promises further brilliant operative possibilities. After-treatment is a very weak chapter of otology, although there are few fields of surgery which offer greater inducement to conscientious study in the certainty of producing a result commensurate with the labor expended.

In his preparations preliminary to making the dressing of the mastoid wound the surgeon and his nurses or assistants should exercise the same care in sterilizing the hands as if they were preparing for operation; sterilized rubber gloves are especially convenient and serviceable under such circumstances.

But few instruments are required in making a dressing and they may be sterilized just before using; under ordinary circumstances the following list will contain all that are required: Bandage shears, dressing forceps, stitch scissors, probe, applicator, syringe, and suitable sponges.

### THE REMOVAL OF THE OUTER DRESSING.

The patient having been placed in bed so that the operated ear is turned toward the doctor and easily accessible, the neck, shoulders, and chest should be enveloped in sterile towels and the bandage divided by shears midway between the centre of the forehead and the affected ear; the outer dressing can then be lifted gently off, usually without occasioning the patient any particular discomfort. It sometimes happens, however, that the outer dressings become soaked with secretions from the wound which subsequently dry and harden, causing the gauze and cotton which have moulded themselves closely about the auricle to adhere tightly to the skin; under such circumstances

the dressings should be thoroughly saturated with warm saline solution before attempting their removal, as the force which must be exercised in detaching them from the ear and surrounding scalp in their dried state will otherwise cause considerable pain, which the above mentioned simple expedient will obviate.

When the outer dressings have been removed the head should be encircled with a sterile towel in such manner as to confine the hair and prevent its contact with the wound.

### THE REMOVAL OF THE INNER DRESSING.

When the mastoid wound has been lined with rubber tissue the removal of the inner dressing or packing is accomplished quickly and absolutely without pain in the following manner: Any fragment of gauze which protrudes between the open lips of the wound is seized with a pair of dressing forceps and drawn gently forth, the moist gauze readily unwinding itself from the depths of the rubber tissue sac. This manœuvre is repeated until the sac is empty, when the rubber tissue itself is drawn from the wound in the same gentle and painless manner, leaving the cavity *free of blood and open to unobstructed and critical inspection.*

After the removal of a mastoid dressing, in the manner just described, the patients are entirely comfortable physically and glad to testify that their apprehensions of frightful pain at the first dressing, which they are usually anticipating as a result of information cheerfully volunteered from the "terrible personal experience" of some well intentioned friend, have not been realized.

When the mastoid wound has not been lined with rubber tissue the method of procedure in removing the inner dressing is the same as already recited above, except that it becomes necessary to exercise very much greater force in extracting the tightly

packed gauze from the irregular and uneven walls of the mastoid cavity into which it has moulded itself.

The gauze clings with great tenacity both to the margins of the cutaneous flaps, where granulations have begun to incorporate themselves in its mesh, and to the bony walls as well. Various expedients have been suggested by the assistance of which it was hoped to free the gauze from its adhesion to the wound and thus obviate the necessity for the customary display of force in its removal and thereby spare the patient the very severe pain attendant upon this step. The practice commonly adopted in the attempt to facilitate the removal of gauze is to irrigate the cavity in the bone together with its contents with hot normal saline solution or hot solution of bichloride of mercury, 1 to 5000. Another agent employed with a similar purpose in view is hydrogen peroxide 3 per cent. used at the ordinary temperature of the room (*it should never be heated*) and permitted to remain in contact with the wound as long as it produces active effervescence. That these and other similar devices are entirely worthless for accomplishing the purpose intended the writer would not maintain; he simply contends that in his personal experience they have proved of no service, while the introduction of rubber tissue in the wound insures an absolutely painless dressing and leaves nothing in the technique of the procedure to be desired.

When, therefore, gauze is to be removed from the wound the operator may as well grasp it firmly with the forceps and draw it steadily and promptly forth; nothing will be gained by pulling for a moment, then resting a while to ease the pain, and then again tugging away at it; such dilatory tactics simply prolong the agony without in any degree mitigating the evil. The more quickly the dressing can be withdrawn, having a proper regard for the sensibilities of the patient and a due consideration for

an appropriate display of force (which must never amount to roughness), the better will the interests of the victim of so painful a procedure be served.

It would be difficult to conceive of a more striking contrast than is afforded by the picture of comfort and satisfaction, on the one hand, of the patient whose dressing has been made with rubber tissue, and of physical suffering and acute mental distress, upon the other hand, of the patient who has submitted to the forcible dragging out of tightly packed and adherent gauze; the latter will testify promptly and with forcibleness that however apprehensive he may have been regarding the pain to be experienced during the dressing his most lively anticipations have been fully realized.

When the packing has been removed the cavity in the mastoid should be carefully scrutinized in order that any detached fragments of bone or remnants of sloughing soft tissues may be detected and removed; if there is present any considerable amount of pus or blood the wound should be cleansed with warm salt solution or bichloride of mercury solution 1 to 5000.

When the gauze wick is removed from the external auditory meatus at the first post-operative dressing it will usually be found moistened with discharge. The canal of the ear should then be irrigated with hot sublimate solution 1 to 5000, and after drying thoroughly, a wick of five per cent. iodoform gauze again introduced. If discharge from the ear still continues after the fourth dressing the use of gauze drainage should be discontinued and the ear should be irrigated every three hours with hot sublimate solution until the discharge entirely ceases.

There is one condition to which reference has already been made which precludes the use of rubber tissue in the dressing, namely, the presence of a wound of the sinus wall; when the mastoid operation has been complicated by such an accident

the packing must be introduced in the wound with more force than is ordinarily employed and must come in direct contact with the wall of the injured vessel; its removal will therefore be attended with proportionally increased difficulty and pain which will not be in anywise diminished by *the necessity for extracting the gauze from such a wound with the greatest care and deliberation lest by the execrise of undue haste or force the protective clot be dislodged from the rent in the walls of the sinus and renewed bleeding ensue.*

The first dressing of a mastoid wound in which the sinus has been punctured during the operation requires the exercise of the most painstaking care and saintly patience in order to avoid embarrassing hemorrhage. The control of sinus bleeding during the operation when a patient is anæsthetized is under ordinary circumstances a simple procedure, but when compelled to deal with a similar difficulty in a patient in the full possession of his senses, who is both excited and alarmed as well as hurt by the manipulation to which he is subjected, we encounter an entirely different proposition, and when an operator has enjoyed a few such experiences he will gladly avoid a repetition of them by any means at his disposal, however tedious and laborious they may be.

In removing the gauze from a mastoid cavity, at the bottom of which lies an injured sinus, a stream of sterilizing fluid (bichloride of mercury 1 to 5000) should be constantly flowing from a gravity syringe over the dressing as it is drawn forth, that all infective products may be promptly washed away before the wound in the sinus is uncovered. In this manner all the dressing is gradually removed, and when good fortune attends upon our careful ministrations to the end, the last fragment of gauze comes away and no bleeding appears to embarrass us. No further irrigation of the wound is necessary; it is already thoroughly

cleansed. But unfortunately the operator's evil genius is at times in malicious attendance upon his most conscientious and sincere efforts, and all will perhaps progress favorably until very near the completion of the step, when the blood suddenly wells up from beneath the packing and the surgeon is offered the choice of two procedures. On the one hand, he can leave the gauze still remaining in the mastoid cavity undisturbed and replace the portion already removed with a fresh and clean supply, which indeed is exactly what he ought to do *if the secretions of the wound are free of odor and the patient does not present evidences of sepsis;* or, on the other hand, he may rapidly remove the remaining packing, checking the gush of blood which will attend that manœuvre by substituting a pad of sterile gauze, which should always be held in readiness against such a contingency, in place of the one thus summarily extracted. The latter procedure would be positively indicated *if the discharges from the wound were acrid or ill-smelling in character or if the patient had manifested symptoms of beginning septic absorption.*

The wisdom of irrigating mastoid wounds as a routine procedure in after-treatment has never been seriously discussed, nevertheless there are reasons to question the advisability of such practice when employed, as is often the case, without proper discrimination. It is but a few years since it was customary with the most skilful and best informed operators to irrigate the mastoid wound at every dressing irrespective of its cleanliness and quite unmindful of the condition of the granulating surface. That such practice was unnecessary and in many instances harmful we now feel well assured, and the disposition at the present time is to irrigate less frequently and less copiously than formerly.

*What advantage may we reasonably expect to derive from the employment of irrigation?*

Irrigation is employed chiefly for purposes of cleansing the

wound of any ill-smelling or acrid discharges and for removing all fragments of necrotic tissue which may become detached during the course of healing. It has little or no value as a therapeutic agent although such properties are commonly attributed to certain of the solutions which are employed.

*What detriment may we possibly apprehend will result from irrigation of the wound?*

When a mastoid wound is granulating rapidly and the granulations are of a bright red color, evenly distributed over the exposed surface and vigorous and healthy in appearance, they will produce only a scanty and thin normal secretion which it is quite unnecessary to disturb. Such granulations are unfavorably affected by copious and frequent irrigation, under the influence of which their consistency undergoes alteration, they are apt to become soft and pultaceous in character, to assume an anæmic or devasculated appearance, and produce an excessive mucilaginous and unhealthful discharge.

When granulations which have been hardy and firm take on any of the above mentioned physical characteristics in the course of healing of a mastoid wound it is not only high time to abstain from further use of irrigation, but it is also necessary to apply a mild stimulating astringent to the secreting surface, such, for example, as nitrate of silver gr. iii to one ounce, or 50 per cent. solution of alcohol, under the persuasion of which agents they should speedily regain their healthy character and tone with rapid diminution of the excessive discharges. We may summarize the situation in regard to the indications for irrigation of mastoid wounds as follows: Irrigation has little or no therapeutic value; it is of service for purposes of cleansing only, therefore if the wound is already clean do not irrigate! When the margins of the cutaneous flaps become sticky or untidy from accumulated healthy secretions, which are devoid of odor and

bland in character, they should preferably be wiped clean with sterile sponges of gauze or cotton instead of subjecting the wound and all the tissues in its vicinity to a thorough and forcible syringing with warm sublimate solution, as has until recently been the routine practice.

Irrigation of mastoid wounds, like many an other admirable expedient, is of value only when it is intelligently employed.

### STITCHES.

The stitches should always be left in position until all the packing has been taken from the wound and until all infective discharges have been removed by irrigation or some other efficient method; the reasons for which may be readily appreciated and are twofold.

First, the lines of sutural union are still very insecure and may be easily separated by even moderate pressure upon the margins of the flaps; their apposition, however, is insured so long as the sutures have not been disturbed. Oftentimes the gauze when it is withdrawn from the bone cavity instead of pulling out evenly, like a thread unwinding from a spool, will kink somewhat and distend the opening in the wound, thus putting pressure upon the flaps which would most likely cause the recent, frail lines of union to separate were it not for the support which the sutures afford.

Second, if the stitches are removed while the margins of the flaps are still bathed with purulent discharges the patient is exposed to needless risk of local infection about the opening in the integument left by withdrawing the sutures, such abrasions affording very convenient avenues of entrance for infective products.

The only exception to the rules enumerated above will be furnished when stitch abscesses make their appearance; as soon

as their existence is recognized the sutures should of course be immediately removed.

After the wound has been cleansed and the sutures have been removed the bone cavity is ready for redressing; it should be partly filled with Peruvian balsam which has been evaporated until it exhibits the consistency of molasses and then very gently packed with wicks of five per cent. (5%) iodoform gauze three-quarters of an inch ($\frac{3}{4}''$) diameter and of any convenient length. A sufficient quantity of gauze should be introduced so that it lies in contact with the bony walls and the under surfaces of the tegumentary flaps, which are thereby supported and prevented from sinking down into the bone cavity.

The employment of Peruvian balsam is very desirable in the first weeks of mastoid dressing because this remedy stimulates the production of abundant and healthy granulations more decidedly and promptly than any other agent with which the writer is acquainted. The balsam is also of great service because it in large measure prevents the gauze, which must be thoroughly saturated with it, from clinging to the bone and flaps and inflicting pain upon its subsequent removal. The use of the balsam should be persisted in with the mastoid dressing until the wound is not only completely lined, but has become well filled with vigorous, firm, and healthy granulations.

In the interest of both the comfort and welfare of the patient it may be well to repeat the advice against forcibly packing gauze into the bone cavity. But one condition warrants such a proceeding, and that has been already emphasized, namely, the necessity for controlling bleeding from the sinus; when that indication is not present forcible packing of the wound with gauze is strongly contraindicated, for it not only inflicts needlessly severe pain upon the patient both during its introduction and its subsequent extraction, but it constitutes a serious obstacle

as well to the development and growth of granulations which we are anxious to produce in abundance and which are necessary to prompt and satisfactory healing of the wound.

Gauze should be so disposed within the mastoid cavity as to afford support to the flaps, a consideration which is commonly disregarded and neglect of which adds materially to the unsightliness of the resulting scar. After the first wick of gauze has been properly distributed in the deepest part of the mastoid opening the remaining strips should be so arranged beneath the tegumentary flaps as to afford support and prevent their sinking down into the bone cavity and adhering to its walls. By supporting the under surface of the flaps with gauze the development of granulations, which serve a very useful purpose, is encouraged; the granulations from the inner surface of the flaps add their bulk to the mass of granulations accumulating within the bone cavity and thereby assist in the production of tissue which if sufficiently abundant will entirely prevent sinking of the scar and reduce the disfigurement of the mastoid cicatrix to a minimum.

When such attention to the support of the flaps is neglected they are forced down upon the granulating sides of the bone cavity by the pressure of the outer dressing and bandage and quickly become adherent in that situation, thereby effectually preventing the production of a supporting cushion of tissue and insuring the patient a deep cavity over the mastoid. Such a scar constitutes a positive deformity and can scarcely be regarded with complacency by the attending surgeon, for in the vast majority of cases a proper attention to the details of the mastoid dressing would have spared the patient the mortification of such an unsightly result.

### Epidermal Implantation.

Constant vigilance is necessary as healing progresses to frustrate the ever-present tendency of the cutaneous margins of the flaps to grow down into the opening in the mastoid process, and the writer desires to call attention to the existence of an agency in the production of this condition which has not been commonly recognized as a responsible factor. The element in question is concerned with implantation of epidermis upon the granulating walls of the bone cavity. Within two or three weeks after operation the granulations upon the most superficial portions of the mastoid wound become small and firm and offer a most favorable surface for epidermal grafting; if at such time nests of epidermal cells are carried by the gauze into the wound and implanted upon this receptive soil, they speedily adhere (quite after the manner of epidermal grafts in any other situation) and form small centres from which epidermis rapidly spreads not only toward the margins of the wound, but toward the deeper portions as well. One not infrequently sees instances to corroborate this observation where the granulations in the depths of the wound are sluggish and do not fill up the opening in the bone promptly, and where narrow promontories of epidermis can be seen extending from the margins of the flaps down into the deeper portions of the wound. These implantations are often caused by carelessly dragging the gauze, as it is packed into the wound, over the cutaneous surfaces of the flaps; small nests of epidermal cells become entangled in the meshes of the gauze, are carried into the wound and held in firm contact with a granulating surface until adhesion is assured.

Such grafting of epidermis upon the granulating walls of the mastoid wound is in no respect harmful to the welfare of the patient and sometimes materially shortens the period of healing.

It should be prevented if possible, not because it is prejudicial to the patient's interests, but because it exaggerates the cosmetic defects of the mastoid operation.

The writer has ventured upon a long explanation of the phenomenon because he has heard operators complain of such experiences who have been unable to prevent epidermitization in wounds which they were most anxious should granulate abundantly and they have expressed their inability to quite comprehend the reasons for their failure.

The question has been asked repeatedly, "What is the necessity of employing iodoform gauze in these dressings when the wound is quite clean and free of any offensive odor? Why not use plain sterile gauze and thereby avoid the possible risk of iodoform poisoning and dispense with the disagreeable odor of the remedy at the same time?"

To which interrogation we reply: The iodoform gauze is employed for purposes of sterilization during the operative dressing only, and is thereafter used solely for the admirable stimulating influence which the iodoform exerts in the production of granulations upon any bone surface with which it comes in contact.

Plain sterile gauze should never be employed in any situation in which it is desirable that abundant granulations shall appear, for the reason that it absorbs all moisture and promptly suppresses the most energetic attempts at regeneration of tissue.

As concerns the possible risks of iodoform poisoning from the small amount of gauze which is employed in the mastoid dressing, the writer considers that such a danger must be regarded as a very remote contingency, inasmuch as in a personal experience dealing with five hundred (500) mastoid operations he has yet to observe the first manifestation of such a disturbance.

The objection raised against iodoform on account of its dis-

agreeable odor is merely fanciful and is not entitled to serious consideration when weighed in comparison with the beneficent influence of the remedy.

Patients whose sensibilities are of such a delicate order as to be unable to endure the slight odor of iodoform which percolates through a thick outer dressing of cotton and numerous coils of bandage are fortunately seldom encountered. For such æsthetic natures xeroform will answer as a substitute.

The application of the outer dressing and the adjustment of the bandage differ in no respect from the procedure already described at the operative dressing.

The steps which have just been described in detail are equally characteristic of the dressings which must follow during the succeeding weeks of healing, and should with hospital and clinic patients be repeated at regular intervals of three days.

With private patients, whose whims we oftentimes find it expedient to humor, no definite rule need be prescribed, and we may make our practice conform to their comfort and convenience so long as their caprices do not conflict with good surgery or jeopardize the ultimate favorable result of the case.

As the wound diminishes in size with the course of healing, growing shallower in depth and less extensive in area, a smaller quantity of both inner and outer dressing will be required until after a period of variable duration, usually of about three weeks in adults, the unsightly bandage can be dispensed with and a black silk pad, which fits closely behind the ear and is inconspicuous, may be employed.

The silk pad will in turn be discarded in a few weeks in favor of a crescent-shaped strip of adhesive plaster which affords the necessary support to the modest dressing still required by the rapidly contracting wound, until such time as complete healing is established and the patient discharged cured.

### How Many Days Must Elapse after Operation before the Patient May Sit Up.

No positive rules can be formulated for guidance in deciding when a patient is so far convalescent as to admit of sitting up. On general principles we may assume that a patient may safely leave the bed to sit or recline in a chair as soon as the temperature has been for three days normal in the morning and has shown an elevation of not more than 0.6° or 1.0° at evening. Should the exertion attendant upon such effort induce vertigo or dizziness or excite the heart unwarrantably as indicated by marked acceleration of the pulse, it will be an indication that the patient's ambition has outstripped his strength.

The process of healing in mastoid wounds does not always pursue to a successful termination the uneventful and prosaic course which we so greatly desire and so highly appreciate. Such wounds have indeed in many instances an exasperating habit of healing in the beginning with astonishing rapidity; so remarkable, in fact, is the progress of the first two weeks that were it not for previous disappointing experiences of a similar character the operator would feel sure that the case would be well in less than a month; and while such a result would not be an unheard-of success in mastoid surgery it would certainly be a most noteworthy performance. But the tremendous energy with which the healing process starts off appears to become expended early in the journey, and not infrequently such a case, notwithstanding its meteoric career in the beginning, lags behind more and more with each succeeding week in spite of stimulation of all kinds generously administered, and ultimately becomes entirely exhausted, and after many weeks ceases all endeavor to finish the allotted task, leaving the perplexed and disappointed operator with a case of incomplete or delayed healing upon his hands.

A certain percentage of such cases is liable to occur in the practice of even the most skilful practitioner.

When in spite of favorable progress in the early weeks of healing a mastoid case finally reaches a stage where it appears vain to hope for further regeneration of tissue, the picture which is presented usually assumes one of two characteristic appearances.

The first and by far the most common manifestation exhibits a firm, laudable scar closing both the upper and lower angle of the original operative incision, while at a point a little above the centre of the cicatrix, and corresponding with the situation of the antrum, an opening presents which leads by a fistulous tract inward, upward, and forward toward the posterior root of the zygoma. The opening which appears in the centre of the cicatrix and which is surrounded by very glossy, shiny red skin, is of variable shape and dimensions, sometimes symmetrically round in outline with sharply defined borders, almost tubular in appearance, nearly devoid of granulations and apparently beginning to epidermize. A probe introduced within this tract may or may not reveal the presence of uncovered bone. In another case the opening may occupy precisely a similar situation, but instead of presenting a sharply defined orifice is recognized only by the presence of a budding mass of pouting granulations, a probe passed through which follows a fistulous path usually to a focus of dead bone.

The second and less frequently observed type of incomplete healing presents a very different picture from the characteristic appearances of the first variety. The prominent feature to be observed is a very broad and thin epidermal scar, of pale reddish color, which has sunken into the opening in the mastoid and become firmly adherent to the bone throughout its entire extent. So few granulations have been produced by the bone

and so scanty has been the regeneration of tissue that the large cavity created by the operation remains unaltered in shape and size, and where the bulging convexity of the mastoid process formerly existed there remains now only a deep bowl-shaped depression or pit down the sides of which epidermis has crept in a thin investing layer which adheres so closely to the margins and walls of the bone cavity that all its irregularities of structure can be plainly seen and felt. The process of epidermitization, however, in this variety of imperfect healing does not progress to complete investment of the depression in the mastoid, but is arrested in its deepest portion, leaving a persistent area of suppuration in a situation which commonly corresponds with the floor of the antrum. This raw spot or unhealed area is always very intractable and sometimes defies for years all attempts at epidermitization, and in a certain very small percentage of cases remains as a permanent ulcerative process which neither the protracted application of remedial measures nor even ultimate recourse to secondary operation is able to eradicate. Such a large excavation in the mastoid region covered only by thin, reddish epidermal scar tissue and maintaining a central focus of suppuration constitutes not only an unsightly deformity, but an annoying and sometimes painful condition as well.

When an operator is so unfortunate as to have in his practice a case of incomplete or delayed healing which corresponds in its chief physical characteristics with either of the above described varieties he will oftentimes find himself at the end of his otological resources in an endeavor to discover some avenue of escape from his embarrassing situation, short of secondary operation. Every kind of appropriate treatment that medical ingenuity could suggest has been resorted to for the purpose of stimulating the flagging energies of the tissues to renewed activity in the production of vigorous granulations, and in the vast

majority of circumstances such unremitting efforts have ultimately been crowned with success, but in a considerable number of cases secondary operation has at length proved the only resource. By secondary operation we mean the institution of a procedure of such a nature as necessitates the administration of an anæsthetic for its successful accomplishment, in which category such simple curetting as is a frequent daily accompaniment of mastoid dressing in the clinic is not included.

What methods of procedure are commonly relied upon in incomplete healing to stimulate the granulations, to remove dead bone if present, and to induce closure of the wound?

When the mastoid wound is of the variety first described, namely, a sharply defined round opening leading by a channel or fistulous path of variable depth into the deepest portions of the mastoid apophysis, whether granulations along its course are, on the one hand, so scanty as to be with difficulty recognized, or, on the other hand, are abundant but soft, anæmic, and pultaceous, the conclusion to be drawn is that superficial dead bone is present and acting as an obstacle to healing.

Such material may be most expeditiously removed by the use of a sharp mastoid curette introduced within the wound and gently and quickly drawn back and forth over the sluggish surface a dozen or more times, pressure being made with the edge of the instrument at any point where roughness of the walls can be appreciated. This procedure should be followed by the injection of some stimulating agent which should be reapplied at intervals of forty-eight hours for several weeks in the hope of producing a sufficient growth of granulations to fill the opening and induce healing. The most serviceable medium of this character with which the writer is acquainted is Villate's solution (sulphate of copper, sulphate of zinc, of each 15 parts; solution of subacetate of lead 30 parts, vinegar 200 parts), the satis-

factory results following the administration of which he has often witnessed. Various other remedies are advised to hasten separation of small areas of superficial bone, some of which, like a strong solution of nitrate of silver (gr. lx–℥i) or dilute nitric acid (½ per cent.), are highly esteemed. Occasionally under the influence of such treatment as has been described a fistulous path will contract until it is extremely narrow, perhaps only large enough to admit a probe readily. Each day the medical attendant expects it to close completely, but many days pass in tedious succession for both the doctor and patient and still the intractable opening persists. As a last resort under such circumstances a steel nail or a roughened fragment of lead wire is occasionally worn in the wound, which closes tightly around it. Daily movements of these irritating foreign bodies will sometimes occasion separation of dead bone and excite a vigorous growth of granulations which, after hope of avoiding a secondary operation had been almost abandoned, close the wound.

What methods of procedure are commonly employed in the efforts to induce closure of the wound in a case of incomplete healing of an epidermal mastoid cicatrix?

When a mastoid wound presents the physical characteristics which we have described as distinctive of the second variety of incomplete healing, it is accessible to applications throughout its whole extent and easily inspected; it is hence less difficult to treat, although not necessarily more tractable to heal. We are dealing with what is practically a process of superficial ulceration, upon the duration of which the condition of the bone beneath may exercise but slight influence. We have no deep hole which we are desirous of filling with granulations, and the only object we have in growing granulations at all in such a condition is that they are needed in order that they may become converted into epidermis.

When we interrogate the granulation tissue of the suppurating area or raw spot with a probe we find it soft and unresisting, easily penetrated with the probe point, and attached to the bone beneath by the most feeble adhesions; so much so that when punctured by the probe it can be lifted away from the bone upon the instrument for a considerable space without lacerating it in the least. We may also observe that under firm pressure of the finger or probe this tissue is very friable and pulpy and exudes a kind of viscid, glairy, mucoid material, much as if it had undergone amyloid degeneration. It is quite evident that any supposed reparative tissue which can be thus readily separated and raised from the bone to which it is accredited can neither impart much nourishment to nor derive much nutriment from that structure. It becomes necessary, therefore, either so to alter the character of such tissue by local application of properly selected remedies that it may be readily converted into epidermis, or to destroy it and substitute in its stead an entirely new tissue, of non-inflammatory type, transplanted from some distant and healthy source, as, for example, an epidermal graft transplanted from the thigh.

As soon after operation as a surgeon recognizes that he is dealing with a case in which granulations will not grow with sufficient luxuriance to fill up the bone cavity and unite with the flaps at its margin, but that the flaps will be compelled to grow down the steep sides of the cavity and unite by a thin epidermal covering at the bottom, he should be on the alert and subject his scanty granulations to such treatment as will keep them in a serviceable condition for conversion into investing epidermis.

As soon as the epidermis appears to lag somewhat in its rate of progress and we notice at several successive dressings that the unhealed area does not appreciably diminish in size, the granulating surface should be submitted for two or three consecutive

dressings to applications of a mild astringent solution, than which there is none superior to nitrate of silver gr. x–℥i. If used in much stronger solution it will exercise an undesirable caustic effect, which should be avoided.

The application of eighty per cent. (80 %) alcohol may be alternated to advantage with the nitrate of silver after it has been employed for a few days; in connection with the silver or alcohol, drying powders should be sparingly dusted upon the granulations and upon the epidermis in the immediate vicinity, an absence of all moisture favoring materially the epidermitization of any denuded surface.

There are several powders which are highly commended for this purpose, among which may be mentioned in the order of their relative value, according to the writer's experience, stearate of zinc; boracic acid and stearate of zinc, equal parts; aristol. When after this line of treatment has been persisted in for a reasonable length of time, say two weeks, we are still unable to appreciate any diminution in size of the granulating spot, we may try the effect of copious irrigations of hot saline solution, using about one gallon every four hours at a temperature of 118° to 122° F., which is quite hot but not too severe for the sensibilities of the average patient. The hot saline irrigation is easily and satisfactorily administered by making use of an ordinary fountain syringe which should be held sufficiently high above the patient's head, about three feet, to insure a rapid and forcible flow being directed against the granulations. The beneficial effect of hot irrigations upon sluggish and pulpy granulations is sometimes remarkable, and it seems to the writer that the reason such favorable results are not more frequently experienced is because its use is not persisted with for a sufficient length of time or else the solution is used in insufficient quantity, at too long intervals and too cold. The patient should never

be entrusted with the personal administration of such treatment if we expect to realize any distinct benefit from it. A nurse should be in attendance who will realize her responsibilities to the doctor as well as to the patient, and who will attend with fidelity to the smallest details; in no other way can we profit to the full extent by the influence of this simple expedient.

Should hot irrigation fail of accomplishing the purpose for which it was primarily employed, its energies will not have been expended in vain, for the granulating area, although still refusing to cicatrize, has under the stimulation of heat lost much of its soft and œdematous consistency and is therefore in a more healthful condition to receive and nourish implanted epidermal scales, with a reasonable probability that they will survive implantation and establish new centres, from which epidermitization of the granulating area may rapidly proceed to completion.

When, notwithstanding the granulations have lost their soft and pulpy character, the progress of cicatrization does not proceed apace, we may find the implantation of epidermal scales to prove a serviceable expedient, and in one or two instances which have come under the writer's observation in which he instituted this procedure the results have been very prompt and satisfactory.

A method as convenient as any for implanting epidermal scales upon a granulating surface may be practiced as follows: With a sharp-pointed pair of scissors snip off from any callous spot in the palm of the hand several minute fragments of epidermis, an entirely painless procedure, and with a slender pair of forceps transplant them upon the surface which it is desired shall cicatrize. These minute grafts (for that is practically what they are) should be applied in two crossed lines, like the arms

of the letter X, corresponding to the two widest diameters of the wound. When once placed in position the grafts should be covered with a protective layer of rubber tissue or gold-beater's skin, upon which the usual dressing of gauze and cotton is laid; by the aid of a firm bandage constant pressure is maintained for five days, at the expiration of which period the dressing should be carefully removed and the surface of the wound critically scrutinized. If several small, pinkish red, slightly umbilicated points are recognizable there is reason to suppose that some of the grafts have adhered, and the protective dressing as already described should be reapplied for a further period of three days, when the grafts will have become so firmly incorporated with the tissue to which they have attached themselves that the rapidly cicatrizing surface will require no further protection with rubber tissue, but may now be dusted lightly over with stearate of zinc and covered with a layer of sterile gauze; in a few days the healing will be complete.

Such a favorable result, however, is to be anticipated in only a very limited number of cases, and we are much more likely to find when the rubber tissue is removed at the end of five days that the epidermal grafts have separated entirely from the surface upon which they were implanted and are to be recognized as small fragments of grayish-white necrotic material, either floating about in the secretion from the wound or adhering to the surface of the rubber tissue which has been in contact with them; in either event the procedure has failed. It may perhaps be worth while, after subjecting the case to some days of further treatment with applications of alcohol, silver solution and hot saline irrigation, to renew the attempt at epidermal grafting, but where a first effort has failed completely there is no great inducement to repeat the experiment.

When the employment of the various methods already de-

scribed has failed to induce healing in a sluggish mastoid wound the operator must resort to the implantation of a Thiersch graft of sufficient size to cover the granulating surface. Preliminary to any attempt at transplanting a graft for the purpose of producing epidermitization by Thiersch's method the bone should be divested of all granulation tissue covering it and should itself be subjected to a vigorous scraping with the curette in order that any superficial scales of dead bone may be removed and that all irregularities of surface may disappear. Which means that we now propose to destroy the granulations upon the growth and maintenance of which so much care and attention has been for weeks expended and transplant an epidermal graft directly upon the denuded bone, in the hope that the skin may derive from the recently polished bone surface sufficient nourishment to insure its integrity and permanency.

It is a matter of no importance from which portion of the body the skin graft is taken provided it is free from hair (in men it is best taken from the inner aspect of the arm, in women from a corresponding portion of the thigh), and there are no special precautions to be observed in cutting it except to be sure that it is thin enough and large enough to cover the denuded bone. The graft may be slipped directly from the razor with which it was cut on to the desired point or it may be transferred from the razor to a broad metal spatula and thus conveyed to the required place. Great care should be exercised that the graft is accurately applied to the bone surface, and when once it is smoothly arranged it should be quickly covered with a protective layer of gold-beater's skin or rubber tissue and dressed after the manner already described in the technique of the procedure for the implantation of minute epidermal grafts.

The Thiersch graft has been employed by the writer with much satisfaction in a small number of cases, and the only in-

stances in which the procedure has been a complete failure in his experience have been in tubercular and diabetic subjects in whom the performance of any more radical operation would have been of doubtful utility.

In an extensive operative practice but few intractable cases of incomplete healing will be found in a period extending over many years, and the author feels confident that if the family and clinical history of such patients could be thoroughly investigated some diathesis or dyscrasia would be disclosed to account for the poor reparative powers of the individual.

The writer has often observed the concern with which men who are beginning their operative experience regard the slightest departure from the course of normal healing; they appear apprehensive of some impending calamity, and hence are disposed to attach entirely unwarranted significance to every unimportant detail which with more extended experience they learn to disregard. Perhaps the appearance of exuberant granulations or so-called *proud flesh* upon the margins of the mastoid wound furnishes a more frequent cause for needless anxiety than most of the other groundless worries which beset and annoy the beginner.

In fact, so acutely sensitive become the susceptibilities of many operators upon the subject of this proud flesh spectre that they are misled into the practice of destroying entirely healthy and much needed granulations under the misapprehension that they are thereby removing an obstacle to healing. Such misguided zeal in the destruction of granulation tissue about the margins and sides of the mastoid wound is doubtless responsible in numerous instances for the production of the sunken and unsightly cicatrices which appear when healing is finally complete. Many men, otherwise competent, fail to appreciate the importance of encouraging an abundant growth of granulations

in the mastoid wound, and do not realize that so far from delaying healing the presence of that tissue in large quantity is the most reliable guarantee of speedy union which we could possibly desire. The presence of an abundance of granulations should never occasion us concern, for when superfluous they are very easily disposed of, but a dearth of such productive elements will always be a source of embarrassment.

Granulation tissue may be classified as consisting of two varieties between which clinical considerations render it very important to discriminate.

The first variety, if permitted to pursue its own course, will gradually contract and undergo organization; it never materially obstructs, although it may, when present in very large amount, slightly delay healing. Such granulations are never indicative of the presence of dead bone. The second variety, if not modified in its surgical properties by treatment, remains flaccid and spongy and will not undergo organization; whenever present it constitutes an insurmountable obstacle to healing. Such granulation tissue invariably indicates the presence of dead bone. Granulations of this type are properly denominated exuberant granulations or PROUD FLESH. The first variety is produced by a healthy wound the regenerative powers of which are so vigorous that cell proliferation is very active under the inspiration of inflammatory stimulus, and large masses of bright red firm granulations appear not only at the bottom and on the sides of the wound but along the margins of the cutaneous flaps as well. When interrogated with a probe the tissue is found to be compact and elastic; it is moderately resisting to pressure; not readily pushed about at its point of attachment, and if lacerated by an instrument bleeds freely but yields only a small quantity of mucoid and viscid material. Such healthy granulations should not be regarded as proud flesh, for if left to themselves they grad-

ually shrink to proper proportion, undergo organization, and become incorporated with the scar. They never constitute an actual obstacle to healing and are rarely responsible for material delay to union even when they are heaped about and overhang the edges of the flaps directly at the points where union is in progress. When, as occasionally happens, there is a superabundance of the tissue just described which elevates itself to a considerable height above the level of the cutaneous margins of the wound, it should be lightly brushed over with nitrate of silver solution, gr. xx–℥i, under the influence of which astringent it will quickly contract to the desired dimensions.

The second variety of granulation tissue, and the only one which may be properly entitled PROUD FLESH, is the product of an unhealthy wound in tissues the reparative powers of which are impaired, and when present in considerable quantity about a mastoid wound must be regarded as unmistakable evidence that dead bone is present.

The physical characteristics of this tissue differ sufficiently from that already described to render the task of differentiation a very simple one. Exuberant granulations present, as a rule, a pallid and anemic appearance, the bright red color of healthy inflammatory tissue being conspicuously wanting, whether they are supplied by the margins of the flaps or by the less vascular walls of the bone cavity. When palpated by a probe they are found to be exceedingly soft and pulpy in consistency and so flabby that they may be pushed about upon the tissues to which they are attached much as if they were small bladders or sacks filled with semifluid contents, and to some such structure they may indeed be not inappropriately compared. When lacerated they bleed copiously and exude a viscid mucoid material in considerable quantity. In such tissue the development of newly formed inflammatory blood vessels is extreme, while the pro-

duction of cellular elements is insufficient. Under these conditions loops and tangles of thin-walled tortuous vessels, microscopic in size, ramify upon and in some instances project beyond the surface of the granulations.

Tissue of the character just described, whenever encountered is universally recognized as an obstacle to healing, and when present in the neighborhood of a bone cavity is conclusive evidence of dead bone. As soon as proud flesh is recognized about the mastoid wound it should be destroyed by curetting and not by the employment of any chemical caustic; such exuberant granulations as are attached to the cutaneous margins should be scraped away with a curette until firm healthy tissue is encountered. The same attention should be directed to the bone, the granulating surface of which must be subjected to a vigorous application of the curette, in the hope that such dead bone as is present may be superficial and easily detached, in which event a healthy surface will be provided for the development of well nourished, tissue-producing granulations.

An intelligent practitioner should find no difficulty in differentiating between healthy granulations which are to be encouraged and protected and exuberant granulations which are with equal diligence to be destroyed, if he will only note with care the physical characteristics of the two varieties of tissue.

In the post-operative care of mastoid wounds a multiplicity of confusing and vexatious conditions arise, many of which are sufficiently mystifying to confuse and embarrass surgeons of the widest experience.

A few of the most frequently recurring manifestations the writer has endeavored to explain, in the hope that he may thereby in some slight degree simplify the perplexities of the bewildered beginner.

That any monograph, however exhaustive in its scope, could

adequately comprehend and lucidly explain the innumerable manifestations, physiological, pathological, and temperamental, which follow in the train of the mastoid operation may well be doubted, and certainly the writer has no ambition to embark upon so unprofitable an enterprise. Under the circumstances, therefore, the beginner need not find cause for discouragement in the fact that his first few cases exhibit symptoms which he has not anticipated or manifest signs the significance of which he is at a loss to interpret. He would be more or less than human were his experience otherwise. When in doubt consultation is his refuge! In the councils of which professional sanctuary he may acquire both confidence and encouragement.

## CHAPTER XVII.

# THE INDICATIONS FOR THE MASTOID OPERATION, WITH DIFFERENTIAL DIAGNOSIS.

## THE INDICATIONS FOR THE MASTOID OPERATION, WITH DIFFERENTIAL DIAGNOSIS.

The recognition of the necessity for the modern mastoid operation is universal and enthusiastic, but as regards the indications which shall determine the expediency of immediate operation or the wisdom of pursuing temporizing measures in the hope of aborting the inflammatory process there is perhaps in the whole field of otology no consideration concerning which greater diversity of opinion prevails or over which more protracted and acrimonious discussion has been waged.

The attitude of the enthusiast who urges exploratory mastoid operation whenever in acute purulent otitis media mastoid tenderness persists for more than twenty-four hours, for the purpose of determining the presence or absence of pus, finds its direct antithesis in the position of the practitioner who is not convinced of the necessity for operation until fluctuation can be readily felt over the mastoid region and beneath the muscles of the neck, and until the evidences of sepsis are disgustingly plain.

It is manifestly impossible to reconcile opinions as widely

at variance as those just recited; still such extravagant extremes have found equally zealous supporters until the student of otological literature, endeavoring to discriminate between the arguments of such conflicting testimony for and against the measure, is bewildered and confused, if not altogether misled.

The task still remains for some convincing writer whose extraordinary experience qualifies him to speak with the voice of authority, to harmonize these incompatible elements, to restrain the precipitate and inconsiderate haste of reckless radicalism on the one hand, and to embolden and excite reluctant conservatism from its timidity and hesitation upon the other, in the hope that a rational symptomatology may be determined upon which shall commend itself to the approval of all.

With our present knowledge of the pathology of mastoiditis all efforts at surgical interference in this region are, of course, directed towards the relief of suppurative conditions only, and any consideration of indications for the mastoid operation must consequently be limited to an enumeration of those inflammatory manifestations which recur with sufficient frequency and regularity to entitle them to recognition as characteristic phenomena.

That all observers are not unanimous as regards their estimate of the precise significance to be attributed to individual symptoms, in nowise discredits or condemns a systematic symptomatology which as a whole is satisfactory and convincing, and that the manifestations of suppurative mastoiditis are susceptible of such comprehensive and orderly arrangement it is our purpose to demonstrate.

While it is true that the diagnosis of pus in the mastoid usually depends upon the existence of certain well-defined local manifestations, the recognition of which in the majority of instances is a matter of no great difficulty for the experienced medical observer, quite independent of any testimony which the patient

is usually anxious to volunteer, it is nevertheless the part of prudence for even the most astute diagnostician to fortify his position with all available data bearing upon the case, and not to ignore or undervalue the patient's statements simply because of their lay origin. Indeed for certain facts referable to the duration and abundance of discharge and the intensity and situation of pain which may in a vexatious case determine us as to the expediency or impropriety of operation, the statements of the patient furnish our only resource; they ought not therefore to be lightly disregarded.

In the appended table the more constant phenomena indicative of urgent necessity for the mastoid operation are concisely and graphically depicted, the classification following the order in which such symptoms are customarily observed and their significance interpreted.

## PERSONAL HISTORY.

| | |
|---|---|
| PAIN. | Duration, situation and severity of pain; more distressing at night. |
| DISCHARGE. | Copious or scanty throughout course of inflammatory attack; suddenly diminished or arrested with increased pain and coincident tenderness. With infants the observations of the attendant must suffice. |

## SYSTEMIC MANIFESTATIONS.

| THE RULE. | THE EXCEPTION. |
|---|---|
| *Temperature:*—Slight elevation. | *Temperature:*—Marked elevation. |
| Pulse, Respiration: Normal rate neither materially accelerated nor reduced. | Pulse, Respiration: Normal rate greatly accelerated or reduced. |
| Indisposition for effort or sustained exertion. | Chills, vertigo, nausea, vomiting, profuse perspiration and decided prostration are to be regarded as indications of intracranial complications. |
| With children the above noted manifestations are usually exaggerated. | |

## LOCAL MANIFESTATIONS.

### PHYSICAL EXAMINATION.

#### INSPECTION.

| THE RULE. | THE EXCEPTION. |
|---|---|
| Face: Usual physiognomy of pain and deafness, otherwise not significant. | Face: Facial paralysis—pallid, apprehensive countenance. |
| Mastoid Region: Negative, until far advanced stage of the disease. | Mastoid Region: Redness, swelling, œdema indicative of mastoid periostitis with cortical perforation over the antrum or at tip or elsewhere. Inflammation far advanced. |
| Meatus: Purulent discharge copious or scanty. Sagging of membranous portion in superior posterior segment. | Meatus: Absence of discharge. No sagging of membranous portion. |
| Memb. Tymp.: Pronounced bulging. Perforation, the location and size of which is significant only when situated in Shrapnel's membrane. | Memb. Tymp.: Bulging slight or not appreciable. Perforation not recognizable. |

#### PALPATION.

| THE RULE. | THE EXCEPTION. |
|---|---|
| Four points of tenderness on the mastoid process the situations of which are enumerated in the order of their relative significance and frequency.<br>1. Antrum.<br>2. Tip.<br>3. Point of emergence of emissary vein.<br>4. Premastoid lamina or posterior wall of bony meatus. The degrees of sensitiveness vary widely in different cases. | Firm palpation over any or all of these parts may, in very exceptional cases, prove negative notwithstanding that purulent mastoiditis has produced extensive cellular destruction. Great caution should be exercised by the examiner lest the apparent absence of tenderness deceive him. |

#### FLUCTUATION.

Fluctuation in the mastoid region signifies the presence of a subperiosteal accumulation of pus due as a rule to a cortical perforation. This symptom is an exceedingly tardy aid to diagnosis and usually implies neglect or incompetence upon the part of the medical adviser.

### BACTERIOLOGICAL EXAMINATION.

Bacteriological examination will determine the nature of the infection; a matter chiefly of prognostic importance.

### FUNCTIONAL EXAMINATION.

Deafness, subjective noises, fullness, and kindred sensations while uniformly present are of no material importance and are entirely devoid of any significance referable to inflammatory involvement of the mastoid process. Deafness quite as profound may exist when the inflammation is limited to the tympanum only as when the antrum and other mastoid cells participate in the process.

## PERSONAL HISTORY OF PATIENT:—

It not infrequently happens that the statements of the patient, instead of affording needed information to the medical adviser, are so contradictory as to confuse if they do not altogether mislead him; notwithstanding which fact, inasmuch as the symptomatology of mastoiditis is seldom objectively entirely convincing, we are compelled to depend absolutely for certain data upon the before mentioned unreliable testimony.

What information then can the average patient impart which the doctor cannot otherwise gain and cannot afford to disregard in deciding upon the indications for the mastoid operation?

### PAIN:—

Regarding the duration, situation, and severity of pain the patient alone can enlighten the doctor, and while pain is by no means a distinctive symptom of mastoiditis, still *deep boring pain which grows worse at night* and which the patient sometimes characterizes as a "sickening or exhausting pain" must always

be regarded as decidedly significant of an inflammation of the bone or periosteum and an acknowledgment of its *persistence* in the mastoid region is an important aid in diagnosis.

DISCHARGE:—

As regards the quantity of discharge from an ear, the observer can quickly assure himself as to whether or not the amount is excessive at the moment of inspection, but as to whether the discharge has been suddenly diminished or quite arrested with coincident pain, tenderness, and temperature only the co-operation of the patient can establish.

A very copious purulent discharge, if it continues for more than a brief period, say one week, is not to be regarded with composure as an evidence of good tympanic drainage and speedy healing, but is rather to be accepted as proof that the purulent process has spread from the tympanum into the mastoid cells, which have become extensively inflamed, with the resulting production of a discharge so profuse as to preclude the possibility of its originating in the tympanum alone.

As an indication of mastoiditis then discharge is only significant when it is present in excessive quantity or when it has been suddenly diminished, or arrested with coincident pain, tenderness, and temperature.

**SYSTEMIC MANIFESTATIONS:—**

The so-called systemic manifestations are in the majority of instances of no characteristic value in mastoiditis, and may in adults be absolutely wanting throughout the entire course of the malady. In childhood, however, the course of a mastoid inflammation is usually punctuated by well defined constitutional disturbance, most frequently of temperature and occasionally of pulse and respiration.

A symptom which is not always present, but which when it exists is entitled to consideration, is decided prostration, or an indisposition for exertion or effort. This manifestation is occasionally exhibited without corroboration of other systemic disturbance. Chills, vertigo, nausea, vomiting, sweating and the like, while frequent manifestations of intracranial infective diseases complicating mastoiditis, are seldom exhibited except in the presence of such complicating conditions.

**PHYSICAL SIGNS:—**

The physical signs of mastoiditis are such as can be readily elicited on inspection and palpation.

INSPECTION:—

CAREFUL INSPECTION OF THE FACE will immediately recognize the existence of facial paralysis when present. Paralysis of the facial nerve save when accompanied by a convincing array of corroborative symptoms is entitled to no consideration as an evidence of inflammation of the mastoid process, although it was formerly considered in the presence of purulent discharge from the ear to point decidedly toward inflammation of that structure. Recent experience, however, shows that this symptom may exist in the presence of simple acute catarrhal disease of the middle ear, that it is fugitive in its character and in no respect significant of mastoiditis.

INSPECTION OF THE MASTOID PROCESS may result in the detection of redness, swelling, and œdema, but the appearances of the region are more often negative. Redness, swelling, and œdema are more frequently present in the periostitis resulting from furuncle of the meatus, or in rare instances from perichondritis of the auricle, but in mastoiditis are seldom encountered save as an indication of periostitis which is a consequence

of perforation of the cortex at the tip or elsewhere upon the process.

INSPECTION OF THE MEATUS shows the presence of discharge and renders plain its characteristics, whether it be purulent or serous in its nature. Upon carefully scrutinizing THE FUNDUS OF THE EAR there will be noted upon the superior posterior wall of the meatus in that portion which is commonly designated as the membranous canal a small sagging tumefaction, rhomboid in outline and of greater or less prominence according as the accumulated pus in the antrum is under greater or less pressure. This symptom may be regarded as the most definite and pronounced of all fundus symptoms of mastoiditis, and when clearly manifested scarcely admits of a reasonable doubt concerning the necessity for operative procedure.

INSPECTION OF THE TYMPANIC MEMBRANE will demonstrate the presence of a perforation, the situation and size of which are matters of no material significance except when the perforation is situated in Shrapnel's membrane, in which event the doctor should suspect that he is dealing with an acute exacerbation of a chronic otorrhœa, and if mastoid tenderness and pain are present he would be justified in advising operation at a much earlier period than the existing inflammatory symptoms would otherwise demand; inasmuch as experience has shown that acute inflammatory processes supervening upon long-standing inflammations are conducive of exceedingly rapid and extensive destruction of tissue and are hence attended with great danger to the life of the patient. The only distinct evidence of mastoiditis which the tympanic membrane affords is a pronounced bulging, the significance of which is precisely of similar import with the sagging of the membranous canal. These two physical signs are usually concomitant evidences of purulent mastoiditis and are due to the same inflammatory causes.

PALPATION:—

To what degree of consideration as a symptom of mastoiditis is tenderness, when accompanied by purulent inflammation of the middle ear, entitled?

Tenderness of the mastoid bone is justly and universally regarded as the one indication distinctly characteristic of mastoid disease, just as soreness is an accompaniment of acute inflammatory processes of any structure or organ elsewhere about the body.

Mastoid tenderness manifests itself in varying degrees of severity from the exquisite sensitiveness of periostitis which shrinks apprehensively from the lightest touch, to the hesitating and dubious acknowledgment in response to very forcible and deep pressure. In eliciting evidences of tenderness of the mastoid bone perhaps as much depends upon the method employed as upon the situations chosen for its early demonstration; our knowledge of the anatomical characteristics of the part leads us to take advantage of its structural peculiarities for purposes of diagnosis, hence we select for examination points upon the mastoid beneath which experience teaches us pus is likely to be located and where the cortex is usually thin; for example, the situation of the antrum and the apex or tip of the bone.

So general is the misconception of the proper method to employ in determining the presence of bone tenderness that the writer is convinced that many doctors are tempted into unwarrantable delay and deluded with a sense of false security by reason of the unproductive results of faulty manipulation, to the serious detriment of their patients. It is indeed no uncommon experience in consultation to have the patient avoid with a jerk of the head and a cry of pain and irritation the searching interrogation of the educated finger upon the mastoid, to

the surprise and mortification of the attending physician, who has confidently announced but a moment before an entire absence of all tenderness in that region.

The source of error lies in the failure of practitioners to discriminate between the diagnostic significance of skin or superficial sensitiveness and bone or deep tenderness; with sensitiveness such as reddened and excoriated skin surfaces would naturally suggest, the most dainty and delicate palpation is more convincing to the doctor and less distressing to the patient than rougher and less considerate handling.

In the effort to demonstrate bone tenderness, however, such fastidious methods will not suffice, and the applied force must be commensurate with the thickness and density of the tissues through which it is to be transmitted; in palpating the mastoid, for example, the object of the procedure is to make sufficient pressure upon the cortex to cause that elastic structure to yield or be indented sufficiently to exercise compression upon the inflamed nerves of the muco-periosteum lining the mastoid cells; it therefore follows as a logical conclusion that the necessary force to be employed in eliciting signs of tenderness will vary in inverse proportion with the extent and severity of the bone inflammation.

Pressure to the mastoid is most advantageously applied with the end of the thumb, using the right or the left according as the tactile sense is better developed in the one or the other, and is to be slowly and steadily employed with increasing force until the capillary circulation beneath the thumb-nail of the operator blanches out distinctly; such pressure when made over the inflamed bone will cause a boring, penetrating, finger-point pain which is characteristic of osteomyelitis but which will not bruise the skin.

It is the custom of some surgeons to demonstrate tenderness

in this situation by forcible jabbing and prodding with the tip of the index finger, an inconsiderate practice which is apt to defeat its own purpose, inasmuch as such punching bruises a delicate skin and inflicts pain which may obscure the appreciation of deeper manifestations.

When a patient refuses to acknowledge tenderness under the persuasion of deep, forcible pressure such as has been described, it is fair to assume that tenderness does not exist, *but such negative testimony is unfortunately by no means conclusive evidence that the pneumatic structures of the mastoid do not contain pus*, which is equivalent to admitting that pus may at times be present in the mastoid cells without causing any soreness of the bone, a proposition the truth of which repeated observation has demonstrated. In determining the presence of mastoid tenderness, four points present themselves as especially significant of inflamed areas, and in the order of their relative importance and frequency of occurrence may be considered as follows:

1. The situation of the antrum (external wall).
2. The tip or apex of the mastoid bone.
3. The point of emergence of the mastoid emissary vein.
4. The premastoid lamina, or the posterior wall of the bony meatus. (Anterior wall of antrum.)

ANTRUM TENDERNESS:—

Is an almost invariable accompaniment of suppurative mastoiditis and its presence is to be detected by making pressure at an angle of about 45 degrees upward and backward from the external meatus and about ¼ inch behind the post-auricular fold; *persistent deep finger-point soreness in this situation is our most reliable and constant manifestation*, and when associated with purulent discharge from the ear is entitled to our most distinguished consideration. In this connection a word of warning

concerning the direction of the applied pressure may not be inopportune lest the presence of a furuncle in the meatus lead to a misinterpretation of the signs; the force of the palpating finger must be directed away from the auricle in such manner as not to exert pressure upon it, for all movements of the ear in the presence of a furuncular inflammation of the meatus are exquisitely painful.

TIP TENDERNESS:—

Tip tenderness, while by no means as constant or significant an indication of mastoiditis as antrum tenderness, is still a very important symptom and is best elicited by making firm pressure from beneath the apex of the bone upward, rather than pressing down upon it. Certain prominent writers upon mastoiditis have of late shown a disposition to depreciate the symptomatic value of tenderness at the tip, maintaining in support of their attitude that the tip is tender to firm pressure in many persons under entirely normal conditions, an observation which is doubtless true, but comparative pressure over the mastoid of the opposite side will establish the identity of the inflamed structure immediately and in no uncertain manner. The experience is indeed a frequent one, to elicit signs of tenderness *at the tip only*, and upon opening the bone to find an accumulation of pus limited to the cells corresponding precisely to the area of tip tenderness, in view of which experience this symptom when persistent must be regarded as an important corroborative sign and ought under no circumstances to be undervalued or neglected.

EMISSARY VEIN:—

Tenderness at the point of emergence of the mastoid emissary vein has by various writers been considered as strongly indicative of thrombosis of the lateral sinus; more recent and ex-

tended observation, however, has established the fallacy of this proposition and indicated the limitations of the value of the symptom as expressed in the testimony which it affords of inflamed bone cells near its point of exit from the mastoid. The situation of the mastoid foramen is exceedingly variable, but in the great majority of instances is found at the posterior extremity of the occipital groove, which corresponds to a point ½ inch above and the same distance behind the centre of the mastoid tip, in which locality pressure will, as a rule, in cases of suppurative mastoiditis cause a degree of pain which is entirely disproportionate to the discomfort of similar pressure elsewhere along the posterior border of the bone. This symptom is naturally more marked when a considerable portion of the mastoid process is inflamed; when therefore tenderness in this situation is pronounced the writer is accustomed to anticipate extensive mastoid destruction oftentimes involving the inner table of the skull and associated with circumscribed pachymeningitis externa (epidural abscess).

As an indication of mastoiditis, while not so frequent as the two preceding manifestations, the writer has so often observed and been influenced by it that he has come to regard it when well marked as a very significant factor and a most helpful aid to diagnosis.

PREMASTOID LAMINA. Tenderness of the premastoid lamina is always present when antrum tenderness is marked; for the reason that the medial plate continues the occipital groove forward and upward and beneath the floor of the bony meatus, which is really the anterior inferior boundary of the antrum, so that pressure made downward and backward in the meatus really demonstrates antrum tenderness from another direction than that at first described. The practice of demonstrating tenderness by interrogating the four points indicated will detect the

presence of tenderness upon the four boundaries of the mastoid process, *above, below, behind, and before*, thus furnishing a satisfactory and comprehensive demonstration of the symptom if it exists.

FLUCTUATION:—

When fluctuation can be demonstrated in the soft tissues of the mastoid it is conclusive evidence that pus has made its way through the cortex and has elevated the periosteum before it; such accumulations are called superperiosteal abscesses, and while furnishing an unequivocal indication for operation are also equally forcible evidence of neglect or incompetence upon the part of some one, and that some one is often the medical adviser. Except in infants,—in whom, of course, the symptom of fluctuation is most frequently encountered, for the reason that in infancy the cortex is soft and thin, particularly in the region of the antrum, while the sutures are by no means firmly cemented, —there is no valid excuse for a failure to detect the presence of mastoid inflammation long before nature has been compelled to relieve the pressure of pus by creating spontaneous openings in the cortex, and even in the mastoiditis of infancy a competent observer ought to be able by a reasonably intelligent interpretation of the physical signs at the fundus of the ear to forestall nature in her efforts at conservative but unscientific surgery.

BACTERIOLOGICAL EXAMINATION:—

Bacteriological examination of the discharge from the ear should never be neglected and should be made at the earliest moment when circumstances admit of it; for while the known nature of the infection will rarely and perhaps never (considered independently of local inflammatory manifestations) definitely determine the wisdom of operating or of refraining from operat-

ing, the recognized character of the discharge will put the attending physician upon his guard, especially should the microscope show that the infection is of pure streptococcus or pneumococcus variety.

In the presence of either of these severe types of infection a surgeon would feel disposed to operate in a given instance at an earlier period, although there might be an absence of some convincing physical appearances in the canal, than he would consider justifiable when the known infecting agent was of a milder type.

For example, when the infection was known to be of pure streptococcus variety, a careful observer would inevitably anticipate by operation the appearance of those more pronounced and characteristic changes which were the infecting agent staphylococcus he would await without anxiety.

There is unfortunately an element of uncertainty to reckon with regarding the value of clinical bacteriological examinations, the discharges for which are collected from the external auditory meatus; such discharges become infected upon being exposed to the air shortly after they escape from the tympanum, and can not be relied upon to present in its purity an example of the infecting medium which is operating within the tympanum and mastoid cells; this source of error must always be present in bacteriological examinations of ear discharges, inasmuch as it is impracticable to obtain for purposes of examination uncontaminated secretions from the tympanum, and when such examination shows the presence of a mixed infection it is by no means safe to assume that the predominating infective element outside of the tympanum is the same agent which is most actively employed within it; that one of the two or more distinct varieties of germs found is the responsible micro-organism must certainly be true, but which of them is the guilty party it

will sometimes be impossible to determine until cultures can be made direct from the mastoid cells at the time of operation. A second or technical source of error also exists in the method commonly employed in obtaining the smear or coverglass specimen for the so-called clinical examination. For example, the report from the bacteriologist will often state that such bacteria as are present are not arranged in characteristic groups or chains, but are found as detached or scattered individuals. Now and again two or three will be found closely approximated, and the examiner inclines to the belief that the inflammation is dependent upon the presence of pneumococci or some kindred diplococci, but when a gelatin culture is made from the same material as the smear the product has repeatedly been found to be pure streptococcus. This experience demonstrates conclusively that the delicate chains of streptococci are very easily disarranged by wiping the cotton applicator with which they have been collected upon the cover-glass, in consequence of which the microscope reveals only scattered individuals or occasional combinations of two or three micrococci, which are really the remains of a fragile chain of bacteria which some more delicate technique would have preserved for ready microscopic recognition.

Notwithstanding the many attendant elements of error which must inevitably diminish the value of clinical bacteriological examination of ear discharges, we are not warranted in omitting such investigation or in regarding the step as discredited, for it is no unusual experience to find the results of the smear examination from the external auditory meatus fully ratified upon subsequent gelatin culture made from the mastoid cells during operation.

FUNCTIONAL EXAMINATION:—

Deafness, noises, fullness in the head, and kindred sensations while uniformly present are of no material importance and

are entirely devoid of any significance referable to inflammatory involvement of the mastoid process.

## DIFFERENTIAL DIAGNOSIS.

| MASTOIDITIS. | FURUNCLE. |
|---|---|
| Pain: The history of onset of attack and character of pain is of no differential value. | Pain: The history of onset of attack and character of pain is of no differential value. |
| Discharge: A copious or scanty discharge from the meatus, the escape of which *does not relieve inflammatory symptoms*. Discharge usually continues for protracted period and *precedes all mastoid inflammatory manifestations*. | Discharge: Swelling of the meatus and mastoid region *precedes the appearance of any discharge*. Upon appearance of discharge all inflammatory symptoms rapidly subside. |
| Temperature: Slight elevation. | Temperature: Slight elevation. |

## DIFFERENTIAL DIAGNOSIS.

### INSPECTION.

| | |
|---|---|
| Mastoid Region and Auricle: Usually negative. Swelling when present extends further back upon mastoid and down to or below the tip, appears late. | Mastoid Region and Auricle: Redness. Swelling and œdema close to auricle and generally high up on the mastoid region, appears early. |
| Meatus: Purulent discharge usually present. Sagging of superior segment of membranous canal only. Outer third of meatus and orifice of normal appearance. | Meatus: Discharge usually not present. Swelling of entire length of fibrocartilaginous meatus often occluding orifice. |
| Membrana Tympani: Easily seen and inspected. Generally a recognizable perforation from which discharge is escaping. | Membrana Tympani: Difficult or impossible to see owing to swelling of meatus. When seen is of normal appearance or slightly reddened. |

## DIFFERENTIAL DIAGNOSIS.

### PALPATION.

| | |
|---|---|
| Auricle: All movements of pressure or traction are *painless*. | Auricle: All movements of pressure or traction are acutely *painful*. Tenderness of preauricular gland. |
| Mastoid Region: Pressure over all points is *painful*, especially on the antrum, the tip, the emissary vein. | Mastoid Region: Pressure over all points is *painless* except when so exerted as to cause movement of auricle. |

FLUCTUATION:—

When fluctuation can be recognized immediate incision is indicated for evacuation of pus; if the purulent collection is due to mastoiditis *a perforation of the cortex will be found and the pus will be subperiosteal in its situation;* if due to furuncle *no cortical perforation will be found and the evacuated pus will be extra-periosteal in its situation.*

In the first instance the usual mastoid procedure must be instituted; in the second instance the incision in the integument will suffice.

DIFFERENTIAL DIAGNOSIS:—

Mastoiditis is seldom to be confused with any inflammatory process other than that of furuncle of the meatus, and while under ordinary circumstances the inflammatory manifestations of furuncle fall far short of the evidences necessary to convince us of the existence of suppurative mastoiditis, it nevertheless occasionally happens that furuncles, especially when situated upon the posterior wall of the meatus, produce symptoms of such gravity as to render a differential diagnosis a matter of very great difficulty. When such furuncle is present the swelling of the meatus is sufficiently extensive to interfere with inspection of the fundus of the ear, for the reason that few patients will endure the intense pain necessarily inflicted in any attempt at a satisfactory introduction of a speculum for the purpose of determining the presence or absence of inflammation of the tympanic membrane.

To add still further to the difficulties of differentiation furuncle upon the posterior wall of the meatus is occasionally productive of a cellulitis so extensive or of a purulent accumulation so large as closely to simulate the subperiosteal abscess of mastoiditis with cortical perforation. In the presence of the latter manifestation even the shrewdest diagnostician may sometimes

be at fault, and on several occasions the mastoid process has been opened unnecessarily under a misapprehension of the conditions existing and in the belief that purulent mastoiditis was present when a furuncle of extraordinary dimensions was the source of the inflammation. In most instances, however, but little difficulty is experienced in differentiating between mastoiditis and furunculosis; when furuncle of the meatus is present any and all movements of the auricle are intensely painful, while in mastoiditis pressure or traction may be exerted upon the auricle in any direction without occasioning pain or even discomfort. As regards the redness and œdema encountered in the periostitis associated with furuncle, it is almost infallibly situated above the line of insertion of the tendon of the sterno-mastoid muscle. While the similar manifestations of mastoid periostitis are likely to involve the entire mastoid area, as in cases of children whose cortical perforations are generally found in the vicinity of the antrum or the swelling and œdema incident to perforation of the tip in the adult involves the lower half of the mastoid process and extends thence as a circumscribed tumefaction downward into the neck.

The cases of mastoiditis which are commonly encountered either in private or institutional practice may be consistently arranged, as far as the physical signs at the fundus of the ear (tympanic manifestations) and the symptoms directly referable to inflammation of the mastoid cells (mastoid manifestations) are concerned, in four comprehensive classes.

1. Those cases in which all the classical inflammatory manifestations both at the fundus of the ear and in the mastoid region are clearly and readily demonstrable.

In this class of cases the duty of the surgeon is plain, the procedure simple, and the result uniformly gratifying. Would that they represented a larger proportion of operative cases!

2. Those cases in which the *manifestations of inflammation in the mastoid bone* (severe, aching, prostrating pain, exquisite tenderness upon palpation and the like) *are especially pronounced from the very beginning of the attack* while the fundus appearances (copious discharge, bulging of membrana tympani, sagging of membranous canal and the like) are at no time sufficiently prominent to be regarded as corroborative features.

3. Those cases in which the above enumerated manifestations of inflammation *in the mastoid bone* are suppressed or delayed notwithstanding that *the fundus appearances have*, especially as concerns the abundance of discharge, assumed exaggerated proportions.

4. Those insidious and exasperating cases in which with no adequate inflammatory changes either at the fundus or in the mastoid region to enlighten or warn us a suppurative osteomyelitis advances with astounding rapidity and when at length the bone is opened in desperation, as a safeguard against apprehended infective brain disease, the extent of the destructive process encountered amazes and mortifies us.

The three last named classes unfortunately predominate numerically and present a most perplexing, worrisome, and constantly recurring problem for solution.

A conservative attitude counsels delay until the mastoid indications coincide with the fundus changes and vice versa; but the operator knows full well how disastrous may be the consequences of waiting for the appearance of symptoms which are pathognomonic, and he will therefore be disposed after one or two deplorable experiences to assume the responsibility of an early and it may even be unnecessary operation, with the attendant hostile criticism which such radical methods are likely to provoke, rather than expose himself to the odium incident to a possible fatal termination as the result of dilatory practice and indecision.

The last enumerated class (4) is apt to be associated with exanthematous diseases (measles, scarlet fever, and the like), which are especially prone to the production of such destructive types of inflammation and should be regarded with particular distrust.

The many rapidly fatal complications of purulent mastoid disease which embellish medical records furnish ample justification for early operation which the patient or his sponsor should understand is exploratory in its nature and undertaken in order that the intolerable anxieties of the situation may be relieved. Should the interested parties refuse to comply with this demand the medical adviser is thereby absolved of all moral and legal responsibility and may await subsequent developments at least with composure if not with indifference.

**RECAPITULATION:—**

In the personal history of the patient those factors which are important as matters of guidance in determining the advisability of the mastoid operation are the duration and severity of the pain coupled with the statement that it is worse at night. This testimony is materially supplemented and strengthened when the patient volunteers the information that the discharge is unduly copious or that it has been suddenly diminished with coincident increase of pain, tenderness, and œdema.

Systemic manifestations are seldom prominent factors in adults, temperature being, as a rule, but slightly elevated and the evidences of prostration but infrequently pronounced. In infants and children, however, elevation of temperature is frequently a marked symptom of mastoiditis, continuing from the onset of mastoid inflammation until the spontaneous perforation of the cortex as a result of nature's kindly effort, or until surgical interference relieves the condition.

Functional examination as already indicated may be disregarded in any consideration of the indications for mastoid operation.

FACIAL PARALYSIS:—

Although an appalling catastrophe as regarded from the standpoint of the patient, should not unduly alarm the surgeon, or lead him into hasty and unjustifiable surgical measures, for should paralysis appear *upon the side corresponding with the inflamed ear*, he must remember that the facial nerve does not traverse the mastoid process in any part of its course and that its involvement in purulent inflammation of the ear does not therefore in anywise indicate suppuration of the mastoid cells, but implies either that the tympanic portion of the nerve is the seat of the lesion or that the cerebellar fossa has already been invaded, in which event an array of symptoms of unmistakable gravity will attend upon the facial deformity and clearly indicate the existence of a simultaneous intracranial infective process.

Redness, swelling, and œdema of the mastoid region must always be regarded as very significant evidence of a severe inflammatory process and unless these manifestations can be clearly demonstrated to be dependent upon furunculosis they are to be regarded as strong presumptive evidence of mastoid periostitis due to cortical perforation.

Pronounced bulging of the drum associated with sagging of the posterior superior segment of the membranous canal is a symptom which is at the present day universally accepted as pathognomonic of purulent mastoiditis, and the importance of its recognition cannot be too forcibly enjoined upon every medical practitioner who undertakes to treat a case of suppurative otitis media. It is not by any means a simple matter for a casual observer to appreciate these signs at their full value, and they

are doubtless in many instances overlooked, not from a disposition upon the part of the attending physician for superficial examination, but owing to an unfortunate misinterpretation upon his part of symptoms which would be easily recognizable to a more experienced observer.

When in addition to the inflammatory symptoms already enumerated we are able to clearly establish the existence of acute tenderness over the situation of the antrum, the tip, the mastoid emissary vein, and the anterior border of the mastoid process (premastoid lamina), our diagnosis is positively and unequivocally manifest and no justification can be found to support the attitude of the surgeon who declines to operate until fluctuation can be felt upon palpation of the tegumentary coverings of the mastoid.

While the writer would deprecate undue and injudicious haste in the performance of the mastoid operation, he would urge that resort should be had to operative measures at the earliest moment when, in the presence of suppuration from the ear, a majority of the symptoms just enumerated are to be recognized, and this attitude he assumes only after a considerable experience in operating and in the uncompromising conviction that *our sins of commission will in this manner fall short of our sins of omission.*

# CHAPTER XVIII.

# ENUMERATION AND DESCRIPTION OF THE INSTRUMENTS REQUIRED FOR THE MASTOID OPERATION.

## ENUMERATION AND DESCRIPTION OF THE INSTRUMENTS REQUIRED FOR THE MASTOID OPERATION.

The writer has frequently been asked by students and doctors attending upon the clinic to prepare for them a list of those instruments and appliances which are required in the performance of the ordinary operation for acute suppurative mastoiditis.

It would be a difficult, if not quite impossible, task to prepare a list which should receive the unqualified approval of every one, even could the question of expense be entirely disregarded; but inasmuch as the pecuniary necessities of some practitioners impose upon them the exercise of rigid economy, they are compelled to content themselves with a meagre armamentarium which a more prosperous colleague would consider as altogether unsatisfactory and incomplete.

Economy in the matter of surgical equipment is always practiced at the expense of convenience and usually of efficiency as well. The writer has endeavored to make the appended list,

without being unduly elaborate, sufficiently comprehensive to admit of performing the needed steps conveniently and quickly, and he is convinced that in such proportion as the list is curtailed, in similar degree will the difficulties and embarrassments of the operation be multiplied. It will, of course, be noted that many of the appliances enumerated are in no sense distinctive of mastoid work, but they are, nevertheless, such as long experience in operating has demonstrated are needful and for the most part indispensable.

1. Razor for shaving patient's head.
2. Scalpels for making incisions for flaps—3, of assorted sizes.
3. Artery clamps, with broad curved beak—1 dozen.
4. Periosteotome—Langenbeck's is most serviceable and desirable.
5. Scissors—2 pair, one straight and one curved on the flat; medium size.
6. Retractors—2 of medium width, with sharp tines.
7. Chisels and Gouges—the author's set of 8 or Schwartze's short set, Tieman & Co. and Ford.
8. Mallet of wood, metal bound, or mallet of lead; wood is preferable.
9. Thumb and dressing forceps with and without teeth. Three pair.
10. Silver probes, substantial ones of 3 assorted sizes.
11. Rongeurs—at least three varieties required, viz., Mathieu, Adams, McKernon. Several others are helpful—Bacon, Dench, Jansen.
12. Curettes—at least 3 sizes of sharp curettes and preferably 6. Those of any maker are adequate; Tieman's preferred.
13. Metal Ear Syringe, with nozzle guard and asbestos packing.
14. Needles—half curve, Hagedorn. Nos. 1 and 2. 1 dozen.

15. Needle-holder—Kennedy & Frech. Sterile catgut and silk-worm-gut.
16. Hypodermic syringe—the aseptic sub-Q.
17. Gravity Syringe—2 quarts.
18. Infusion Apparatus for normal saline solution.

If the above enumerated instruments are judiciously selected, no operator, provided he possesses the requisite moral fortitude and manual dexterity, need apprehend the mortifying experience of encountering any operative complication for the prompt and satisfactory solution of which his equipment will prove inadequate.

The writer has often been invited to assist at operations where the instruments provided, notwithstanding that they were sufficiently numerous, have been so unsatisfactory as regards pattern as not only to retard the operation, but to convert an ordinarily simple procedure into an exceedingly difficult one as well.

There is no economy in buying obsolete styles of instruments; the most recent and best are none too good. The possession of certain qualities makes an instrument very valuable and the lack of the same properties renders it practically worthless; the author trusts that the appended brief description may furnish a valuable hint to some inexperienced reader and possibly save him the future annoyance of an ill-advised investment in a collection of instruments which, although representing a considerable outlay, are of little value except for scrap-iron.

## RAZOR.

Any razor which is at hand will serve for shaving the scalp, but if one is to be purchased for such purpose it should have a heavy blade and either be plain (that is flat) on both sides or concaved on one side only. The double concave razor is apt to be too light, with an edge much too delicate, for such work,

for the hair of the average person is tough and offers a good deal of resistance which is best overcome by a stout blade.

## SCALPELS.

The considerations which control our choice in the selection of scalpels will be the size, shape, and weight of the instrument, the readiness and thoroughness with which it can be sterilized, and its durability.

The knife which will be found most uniformly serviceable is one about six inches long, having a steel handle forged out of the same piece of metal with the blade; it is of medium weight and so shaped that when lying upon its side a line drawn through the centre of the handle and extended upon the blade passes through the centre of the knife point—that is to say, the blade is straight; those blades the points of which turn up or down are not desirable—the straight blade is best.

Such an instrument is durable, balances well in the hand, and can be quickly and easily sterilized; for mastoid work three sizes of these scalpels are necessary, for while the intermediate size will prove convenient for such incisions as are needed in most operations, the largest of the three will be more serviceable when the tissues over the mastoid, as is not infrequently the case, are greatly swollen; while the smallest and lightest of the set is more suitable for use upon the delicate integument and unresisting bone of small children and infants.

The notion that one scalpel is as good as another, provided the blade is strong and the edge sharp, is incorrect; there is much to choose between the graceful and slender knife which balances well in the hand and the clumsy and unwieldy substitute which is often provided in its stead. An admirable set of knives is made by Tieman & Co., of New York.

## ARTERY FORCEPS.

There is perhaps no instrument in use by surgeons to-day which presents such a heterogeneous array of obsolete styles and antiquated patterns as the artery forceps. Every instrument-maker seems to have on hand an inexhaustible supply of archaic devices (some of which appear to have been contemporaneous with the tourniquet) which he is willing to dispose of at a liberal concession from the regular price, a consideration which is apt to prove an irresistible attraction to the unwary purchaser and which probably accounts in a measure for the perpetuation of these faulty models when their day of usefulness has long since passed. Moreover, many operators are not particular in regard to the style of hæmostat furnished them and seldom discard any specimen from their own armamentarium, however loose-jointed and decrepit it may have become, so long as it can still be made to lock.

In the selection of the most serviceable forceps to-day there are three considerations which should govern our choice, namely: a proper handle, a strong and convenient lock, and a sufficiently broad curved beak.

The handle of an artery forceps should be precisely like that of the ordinary scissors, so constructed that the thumb and finger introduced within the finger holes enables the operator to maintain a firm grasp and affords him perfect control of his instrument; all modern hæmostatic forceps are constructed after this manner, whereas a few years ago the thumb or dressing forceps was the recognized pattern for the artery clamp as well, but it was a very unsatisfactory substitute for the present device.

The lock of the forceps should be of the automatic variety, such as is now almost universal in its adoption since the introduction of the Pean hæmostat; it consists simply of overlapping notches on the inner aspect of each shank so constructed that

the force applied in compressing the bleeding tissues induces simultaneous locking of the blades.

This variety of lock leaves nothing to be desired and its superiority as compared with the bolt and slot lock of the old-fashioned instruments is an eloquent tribute to the progress of mechanical art in surgical equipment.

There is a decided advantage gained in having the beak of the forceps broad and slightly curved; the broad beak more readily grasps the bleeding vessel and does not bury its point in the tissue; it is hence much easier to apply a ligature over such a forceps than over a narrow pointed one which buries its tip so deeply into the tissue that it is with much difficulty one can avoid including the extremity of the forceps in the ligature.

The curve of the beak is a convenience in that it permits the instrument while still locked upon the tissue to fall to one side away from the direct field of operation and thus to occasion less embarrassment to the operator.

## PERIOSTEOTOME.

There are numerous devices used for detaching the periosteum from the mastoid process and all are more or less efficient when employed in competent hands, but a serious objection to most of these instruments is that they are designed with the sole idea of denuding the bone of its investing membrane in the shortest possible space of time with no apparent appreciation of the importance of preserving that membrane for purposes of nourishment and subsequent regeneration of osseous structures.

In other words, most of the periosteotomes cause such extensive mutilation of the periosteum in the course of its removal that it is thereafter of little value as an agent in the repair of bone.

When any single instrument is admirably adapted to the accomplishment of the purpose for which it was designed it be-

comes a superfluous task to enumerate several other appliances of comparative degrees of merit. The Langenbeck periosteotome fulfills all the requirements of such an instrument; it has a hoe-shaped blade with a bevelled scraping edge and a broad shank and handle with sufficient length and strength to afford a firm grip for the hand with adequate leverage for the exercise of the required force, which is oftentimes considerable.

When carefully and intelligently employed the Langenbeck will enable the operator to detach the periosteum from any bony surface, however rough and irregular it may be, without mutilating this important tissue to such an extent that it is thereafter when reapplied to the bone incapable of affording nourishment. It is much more important that the periosteum should be stripped from the bone with an eye to its future usefulness, than that its integrity should be sacrificed to an effort at unnecessarily rapid operating.

## SCISSORS.

No very explicit advice is required in relation to the selection of scissors for use in the mastoid operation. Two pair are sufficient to meet the requirements of the situation; they should be stout but not too heavy, and about five and one half inches in length.

The one pair should be straight with moderately sharp points, the other pair curved on the flat and blunt pointed.

## RETRACTORS.

Retractors are indispensable in the mastoid operation, and in making a selection of them three considerations should govern our choice, namely, sufficient length, proper width, and a convenient and comfortable handle. The most serviceable retractor is about eight inches in length, having a handle which terminates in an

oval loup of sufficient size to admit of the ready introduction of an assistant's thumb; the tines of the instrument should be sharp pointed, four in number, and have an aggregate width of three-quarters of an inch. Two such instruments are necessary.

A retractor which is of insufficient length is a source of annoyance to the operator and to his assistant as well, and moreover does not contribute to the welfare or comfort of the patient. The operator is bothered because the hand of the assistant, in retracting the flaps, is too close to the field of operation; the assistant is wearied because he is obliged to drag forcibly and for a considerable time, upon the auricle and flaps in order that his hand may be as far as possible removed from the operative field; the interests of the patient suffer because such excessive and needless traction-pressure diminishes the vitality of the tissues, produces soreness of the part, and interferes with subsequent healing of the wound.

The handle of the retractor should terminate in some kind of a loup, through which the thumb or finger can be thrust, in order that the strain upon the hand of long sustained traction may be materially diminished. Any person who has ever experienced the aching cramp of the hand caused by holding a retractor which is not provided with such convenience will appreciate the importance of the loup or ring in the handle.

In order that the retractor may secure a firm hold upon the flaps it is necessary that it be composed of sharp pointed tines, as it is otherwise liable to slip frequently (usually at inopportune moments); the tines should be four in number and have an aggregate width of three-quarters of an inch ($\frac{3}{4}''$), for if narrower they do not support enough of the flap and if much wider they are too bulky and cumbersome and exercise undesirable pressure upon the tissue.

## CHISELS AND GOUGES.

If there be one instrument more than another which is inseparably associated in the mind of the medical practitioner with the performance of the mastoid operation it is the chisel or gouge, and although the part allotted to the chisel is by no means as important in our modern operation as it formerly was, before the advent of the rongeur, it is none the less an absolute essential and fundamental dependence now as it was in 1873 when Schwartze first advocated its especial fitness for purposes of mastoid surgery. In making a selection of chisels and gouges three considerations should govern our choice, namely, the length of the instrument, the convenience of the handle or grip, and the shape of the cutting edge.

When Schwartze in 1873 published the results of his splendid operative work upon the mastoid, the impression created by the scholarly contribution of that sturdy pioneer was profound and far-reaching, and to such an extent did his experience transcend that of other observers that his opinions upon matters referable to mastoid surgery were regarded by his many ardent disciples as inspired utterances; with such lustre did the magic of Schwartze's name invest every device which he indorsed that the set of chisels and gouges employed by him was copied and sold the world over and has for years enjoyed a popularity and vogue which its actual efficiency, it seems to the writer, has never quite warranted.

The author realizes that he is exposing himself to an indictment for sacrilege in thus rashly suggesting that there ever was or could be a set of mastoid chisels which for convenience and efficient service might rival the original Schwartze model; none the less such is his conviction after having, until recently, employed them exclusively for many years.

The Schwartze set consists of eight chisels and gouges which

ing to the width of the cutting edges; they are six and three-quarters inches ($6\frac{3}{4}''$) in length, including the handles. (See illustration.)

These chisels are much larger than the Schwartze instruments, but are neither bulky nor heavy; a special feature of their construction which strongly recommends them to the author is the handle with which they are provided, the design of which is very similar to that employed in the carpenter's tool; this handle or grip is four inches in length and is made of a very thin sheet of steel which is spun around the upper four inches of the shank of the chisel, to which it is welded above and below in such manner as to make a water- and air-tight joint. The fact that the shank of the chisel passes through the entire length of the handle and is welded to its top contributes very greatly to the structural solidity of the instrument and to its technical efficiency as well, for the force of the mallet stroke is thus transmitted directly to the cutting edge. The grip just described adds not only to the convenience of its use, but to the precision of the instrument as well because of the steadiness which the grasp of the full hand imparts, a very necessary quality when the important character of the structures which occupy the field in which it is employed are taken into consideration. The blades of these chisels present unusually wide bevels, in consequence of which they are capable of holding a very fine edge and can be made to remove an exceedingly thin shaving of bone; it is always desirable to avoid a thick, stumpy chisel having a short or abrupt bevel. The foregoing remarks are equally pertinent in their application to the gouges of the mastoid set. This set has been manufactured by many instrument-makers, most of whom, in order that they might reduce the cost of production, have disregarded those distinctive features of the instrument which the author regards as essential, and they are sold without his approval

or indorsement. The sets made by Tieman & Co. and by Ford are accurate and may be relied upon.

## MALLET.

There are three varieties of mallets commonly employed in mastoid work, and when enumerated in the order of their relative value as surgical appliances they are constructed of wood, lead, and rawhide. The most serviceable and durable mallet is turned from a block of hard wood and is bound at each extremity with a metal rim or hoop to prevent splitting or chipping; the advantages of this mallet are that it presents to the chisel a sufficiently broad surface or face, which remains smooth or even for a long time; it is heavy enough, is durable, and is readily sterilized.

The lead mallet answers the purpose for which it was designed only fairly well, for while it is easily sterilized its soft lead face is not at all durable and after being used a few times, particularly when dense sclerotic bone is encountered, becomes so indented and uneven as to render it practically unserviceable; a further objection to it is that it is usually made inconveniently small in order to avoid excessive and undesirable weight.

The rawhide mallet is but seldom used, and the difficulty of sterilizing it condemns it as a surgical appliance.

## THUMB OR DRESSING FORCEPS.

Thumb and dressing forceps have not been changed appreciably as regards their pattern within the memory of man, it is hence an easy task to select two or three pair, of which at least one should be of the mouse-tooth variety; these forceps should be of about five inches (5″) length with good, stout blades. The forceps can be held rather more conveniently when the outer surface of the blades has been milled or roughened, but the mill-

ing need not be insisted upon if the instrument is otherwise satisfactory.

## SILVER PROBES.

Probes of three sizes are desirable during the performance of the mastoid operation. One very slender and ductile probe for the purpose of interrogating the aditus and tympanum if necessary, with the minimum degree of risk of damage to the ossicles; another of medium weight and stiffness, which will be used in the majority of circumstances, and a third of still greater weight and length which, although but seldom needed, is occasionally of great assistance. The two larger varieties should be equipped with the bodkin eye in order that gauze may be threaded through them if required.

## RONGEURS.

The development of the rongeur, and its intelligent use more than any other consideration, has modified the technique of the modern mastoid operation as practiced in America, and together with a more accurate knowledge of the surgical pathology of mastoiditis has caused us to depart widely from the steps of the original procedure as advocated by Schwartze. It may be truly said that the chisel is the fundamental dependence of the mastoid operation, and it can be asserted with equal truth that the rongeur is its indispensable supplement; the various models and sizes of rongeurs have greatly simplified the procedure upon the mastoid, have reduced the duration of the operation, and have to a great extent eliminated the dangers of serious accident and facial disfigurement.

Much greater dependence is placed upon the rongeur as a factor in the mastoid operation in America than in Europe, where the chisel and gouge still continue to be the chief reliance. There

are some operators who dispense with the rongeur entirely, which method it seems to the writer must prolong the operation very materially.

It is of course quite possible to bring a mastoid operation to a satisfactory completion with the assistance of but one rongeur, and if the writer were from necessity restricted in his choice to the selection of a single pattern of these instruments, he believes that the type devised by Adams would, all things considered, be found most uniformly serviceable. The conditions, however, which arise oftentimes in the course of the operation are such that time is saved and risk of accident avoided by having recourse to appliances of various sizes and shapes. As the result of considerable experience in operating the writer finds it expedient as a matter of economy of time and conservation of energy to have at hand four varieties of rongeurs, the different designs of which qualify them to fulfill any contingency which may confront the operator. There is no necessity for an elaborate description of the indications for the use of the various rongeurs; their size and shape will signify clearly the purpose for which they were intended. For example, the Mathieu with its broad beak and powerful jaw is intended for cutting away the hard cortex, while the long and slender jaw of McKernon's instrument is specially adapted to removing the cellular structures within the body of the bone.

The only caution which need be exercised in the purchase of the rongeurs which have been enumerated, if they are supplied by reputable dealers, is to observe that the edges of the blades are sharp and meet in properly accurate contact.

## CURETTES.

The curette is a very important instrument in the equipment of a surgeon and when used under favorable conditions removes

the cellular structures of the mastoid expeditiously and safely. The instrument can be used to advantage at various stages of the operation where the employment of the chisel would be attended with unwarrantable risk of injury to important vascular and nervous structures and where the rongeur would be ineffective or impracticable, owing to the remote situation of the diseased tissue to be removed and the narrow limits of the adjacent boundaries.

Inasmuch as the operator is often required to work at considerable depth and within very circumscribed limits, it is necessary that he have at his command several curettes, the spoons or blades of which are graduated in size from one-twelfth to three-eighths of an inch ($\frac{1}{12}''$ to $\frac{3}{8}''$) in diameter; such instruments are more uniformly serviceable when they are oval in shape rather than round, and at least three sizes are required, while a greater number contributes to the ease and satisfaction of operating.

The Volkmann set of curettes, six in number, is made by all instrument-makers and admirably meets the requirements of ordinary cases; some latitude may be permitted the manufacturer in the length and bulk of the shank and handle of these instruments, but they should not exceed six and one half inches ($6\frac{1}{2}''$) in length, nor be shorter than five and one half inches ($5\frac{1}{2}''$) over all. When such instruments are purchased from a reputable dealer the only caution necessary to observe in their selection is the condition of the cutting edge, the difficulties of sharpening which are such that the artisan who fashions it is prone to neglect it.

## EAR SYRINGE.

There are many varieties of ear syringes, and so far as the simple act of throwing a stream of sterilizing solution is con-

cerned any one of them will answer the purpose. In selecting a syringe there are two considerations which should govern our choice, namely, the ease and thoroughness with which it may be sterilized and the reliability of the syringe.

Many syringes are difficult to sterilize because they are constructed of different materials in their component parts. For example, we not infrequently encounter a combination consisting of a glass barrel with a hard rubber or metal nozzle and cap, the joints of which are seldom tight and usually serve as very inviting retreats for germs of all kinds.

Such syringes depend upon the employment of leather washers for the accurate closure of the piston valve, which valve can be rendered sterile only by boiling sufficiently prolonged to cause rapid softening and disintegration of the leather; consequently syringes of this type are neither durable nor trustworthy.

The most durable and reliable syringe is constructed of one material throughout, preferably, because of its durability, of metal; the valve, which is tight, reliable, and always to be depended upon for immediate use, is composed of asbestos instead of leather packing. The efficiency and convenience of this syringe is increased when it is provided with a metal nozzle guard, the purpose of which is to prevent the indiscriminate sprinkling of clothing and of structures contiguous to the wound by the spray which rebounds when the solutions are forcibly expelled from the syringe. Such instruments are sold by all dealers.

## NEEDLES.

The most uniformly convenient and serviceable needles for closing the angles of the mastoid wound are of the Hagedorn variety, which are easiest manipulated when possessed of a full half curve.

The reason for accentuating the curve of the needle will be

found in the relation which the situation of the auricle bears to the wound; if the needle is sharply curved it is a matter of no inconvenience to introduce it through the integument of either flap.

It is quite unnecessary to dwell upon the facility with which these needles penetrate tissue, for the peculiar adaptability of their cutting points to such purpose is universally recognized and appreciated.

Numbers one (1) and two (2) are the sizes which are generally regarded as most satisfactory; they are inexpensive, and a dozen is the smallest number with which an operator should be supplied.

## NEEDLE-HOLDER.

Any needle-holder that will hold a needle firmly will answer, but there are some new models of these instruments which are especially convenient and which commend themselves to the purchaser; the very best appliance of this kind is, in the opinion of the writer, one devised and manufactured by Kennedy & Frech, which has a universal clutch (not requiring that the needle shall be laid in a groove before it is grasped), and which locks and releases automatically by simply exercising the pressure required to hold the needle.

The instrument is furnished in three sizes, the intermediate or second size being best adapted for use in mastoid work.

## STERILE CATGUT AND SILKWORM-GUT.

Sterile catgut for ligatures and silkworm-gut for sutures may be had, conveniently and inexpensively prepared, in small hermetically sealed tubes; this method of procuring sterile suture material is absolutely reliable and economical as well, for there being but a small quantity of gut in each tube there is little opportunity for needless waste.

Several firms of chemists have devoted special time and attention to the task of perfecting sterilization of sutures and ligatures, and their preparations are reliable in quality and reasonable in price; directions for the proper use of the materials furnished accompany each sealed tube.

The sterile catgut prepared by Geo. St. John Leavens is in every way satisfactory; it is compactly and neatly wound, is easily carried, remains sterile, and retains its tensile properties indefinitely. Numbers two (2) and four (4) are most uniformly serviceable.

## HYPODERMIC SYRINGE.

The majority of hypodermic syringes can be rendered sterile only by prolonged boiling, and many of them are open to suspicion even then for the same reasons which have been advanced against the ordinary ear syringe. There are, however, several admirable syringes now on the market constructed entirely of glass and devoid of joints; some of these, unfortunately, are so fragile as not to be practicable for ordinary clinical use, but others again of less delicate construction are very durable. Such an instrument is the aseptic sub-Q hypodermic syringe (Randall-Faichney Company); it is always ready for immediate use and simply requires that the whole instrument be placed for a moment in the sterilizer. It is an eminently satisfactory syringe.

## GRAVITY SYRINGE.

A gravity syringe is an important accessory to any surgical equipment, and its presence may on some important occasion afford the operator an opportunity to relieve shock promptly by throwing a quart or two of hot normal saline solution high up in the bowel; it is frequently found necessary to practice such

a procedure with small children when the operation has been unavoidably prolonged.

## INFUSION APPARATUS.

The occasions when intravenous saline infusion is demanded after the performance or during the progress of the ordinary mastoid operation are fortunately rare, but none the less they now and then occur and sometimes constitute a very embarrassing experience, particularly if the necessary apparatus for the relief of threatening collapse is not at hand.

A very simple device will answer, and in an emergency a gravity syringe is often employed for the purpose, a metal canula having been connected with the tubing and introduced into the median basilic vein.

A satisfactory and inexpensive infusion apparatus which is used in most of the hospitals consists of a glass beaker shaped like a beer mug and of fifteen hundred cubic centimetres' (1500 c.c.) capacity. The vessel is graduated to indicate each two hundred and fifty cubic centimetres (250 c.c.), and from its bottom there projects at right angles a spigot, to which a rubber tube or hose is attached, which in turn is connected with a metal canula for introduction into the vein.

The graduations on the glass beaker enable one to determine readily the quantity of saline solution which is used, together with the rate at which it is being introduced; it is therefore capable of more intelligent application than the rubber gravity syringe.

As has already been said it will, of course, be noted that many of the instruments enumerated and described are in no sense distinctive of mastoid surgery, but they are nevertheless such appliances as long experience in operating has demonstrated are needful and for the most part indispensable.

It is probably true that much of the foregoing description concerning the special features which mastoid instruments should possess is superfluous for many readers, none the less it is written in the hope that it may afford some student of limited experience a valuable hint which may spare him the mortification of purchasing instruments which are antiquated and worthless.

# CHAPTER XIX.

# CONCLUSION.

## CONCLUSION.

The numerous and important modifications in the mastoid operation which the last decade has witnessed have concerned themselves chiefly, if not entirely, with efforts so to improve the technique as to reduce the mortality of the procedure and diminish the frequency of secondary operations, in all of which laudable endeavors the minimum amount of consideration has been expended upon any attempt at reducing the discomforts of the patient incident to dressings and other post-operative manipulation.

The one inflexible purpose has been to cure the disease, and the sensibilities of the patient, in the pursuit of this ambition, have been regarded by the medical attendant with heroic indifference. Now, while fully concurring in the precept which makes a cure the first essential, to be accomplished at all hazards, and while endorsing the method which subordinates every expedient to that end, the writer believes that it is only humane and will in nowise detract from the thoroughness of the proce-

dure so to arrange the dressings as to reduce to the minimum the pain of post-operative treatment. There has been a disposition to regard such elegancies of practice as rather superfluous, and to consider the patient sufficiently fortunate to have recovered his health and regained the function of the affected organ without bothering one's head unduly concerning the thorny pathway over which the sufferer must approach the coveted goal.

Just as modern therapeutics has made grateful concessions to the formerly outraged but vainly protesting stomach in the interests of the patient's comfort and without prejudice to his welfare, so in like measure the sufferings of the victim of mastoid surgery may be decidedly mitigated and the discomforts of his situation materially lessened by the introduction of technical refinements which detract in nowise from the efficacy of the operation, but which are to the patient a source of inestimable relief and gratification not to be measured by ordinary standards of physical comfort, and to be appreciated at their full significance only by those who have experienced the ease of the one and the discomfort of the other method of procedure.

The employment of rubber tissue in dressing the mastoid wound at time of operation is not a matter of necessity, and so far as the writer is aware is used for such purpose by himself alone, although surgeons have long since taken advantage of its flexibility and impermeability (which prevents granulations from adhering to it) to facilitate dressing and aid drainage.

Any doctor who has ever officiated at the removal of gauze from the mastoid in the first dressing of the wound will testify to the severity of the pain inflicted by dragging out the tightly packed material, the resistance of which the soakage from the secretions of the wound has greatly increased.

The pain is sufficient to occasion complaint from the most stoical adult, while the torture inflicted by the procedure upon

small or feeble children or babies is truly distressing to witness, the more so as it is needless, for it can be absolutely avoided by using rubber tissue after the manner just described; and in the opinion of the writer the dictates of simple humanity leave to the operator no choice but to accept this, or some equally efficient method, at once.

The reasons which have induced the writer to adopt the flap operation as the routine procedure in mastoiditis, and which are to him convincing in their significance, may be thus briefly summarized: Without doubt the difficulties and many of the dangers as well of the mastoid operation have depended largely upon the inability of the operator to see clearly what he was doing, owing to the custom of working within a needlessly contracted field, a practice which has until recently been regarded by all otologists as *de rigueur;* this element of embarrassment and uncertainty the flap operation is calculated to entirely eliminate; it contributes therefore in great measure to the simplicity of the procedure, since under such conditions the entire mastoid apophysis is exposed to view at one time, admitting of a much more comprehensive conception of its structural and surgical relations.

As regards the formation of cicatrices, they are not more extensive or unsightly than the resulting scars of the single curvilinear incision, for which the great dragging upon the edges of the wound by the retractors, necessitated where the simple incision is employed, in the endeavor to obtain a clear field of operation is in some degree responsible. The one obvious advantage which the flap operation offers—and it speedily becomes indispensable—is an opportunity to see easily, without embarrassment, and at one time the whole mastoid apophysis, thus insuring a comprehensive view of the operative field, which no single incision, be it stretched never so wide, can possibly supply. (See Plate V.)

A second and distinct benefit conferred by the flap operation upon the author's cases has been an unquestioned shortening of the duration of post-operative treatment, which consideration alone is of sufficient moment, when fully established, to entitle the procedure even were it possessed of no other commendable qualities to careful consideration.

The removal of the pneumatic spaces and diploic cells at the posterior root of the zygoma the writer considers an essential step in the completion of the operation for suppurative osteomyelitis of the mastoid process.

That these osseous structures, investigation of which is usually disregarded, contribute to the necessity for secondary operation with a degree of frequency greater than is commonly ascribed to them the writer thinks an entirely warrantable assertion, since in every instance where secondary operation has been required in his service (after the tip had been removed at the primary operation) the offending agents were found with uniform regularity, both by means of probing and later by inspection upon reopening the wound, in the anterior superior angle of the suprameatal triangle; in other words, in that portion of the temporal bone which constitutes the posterior root of the zygoma.

Any surgeon who has not habitually opened the pneumatic spaces in this region during his operations upon the mastoid will experience surprise at the extent and depth which they often attain, especially in dolichocephalic skulls (see Plate G), and when he has observed the amount and character of pus and other septic materials which these cavities in many cases of purulent mastoiditis contain, he will no longer wonder that such products when permitted to remain undisturbed within the bone lead with frequency to subsequent death of contiguous structures.

When we consider the situation of these cells in their inti-

mate relation with the antrum, aditus, and attic, in which cavities pus accumulates early in the course of suppurative mastoiditis and about which the greatest violence of the attack is often expended, the frequency with which they participate in the inflammatory process should not occasion surprise, but should rather have been anticipated. The thorough removal of the zygomatic cells in conjunction with a similar treatment of the mastoid tip has proved in the hands of the writer an unequivocal success, and he earnestly commends the procedure as a method calculated when conscientiously pursued to produce a satisfactory result in every instance.

What positive advantage, then, does the complete mastoid operation offer which the incomplete procedure does not possess? The complete operation assures the patient almost absolute immunity against all secondary operative measures, with relief from the associated mental distress and physical discomforts which accompany them, a degree of security, in fact, which the incomplete operation is far from affording, and an assurance which, could the patient fully comprehend its import, would leave the surgeon no discretion in the premises; it seems a wise and satisfactory provision and certainly contributes to the tranquillity of mind of both patient and doctor.

The only valid objections raised against the complete operation are upon cosmetic grounds purely, which reasonable reflection demonstrates are trifling and, in comparison with the assured benefits bestowed, insignificant in the extreme.

The antagonism which has been aroused against the most recent advances in the surgery of the mastoid region is simply an echo of former impotent protests which have, since times forgotten, attended and invoked disaster upon every step of surgical progress in connection with procedures about the ear.

The investigator who seeks to expose the fallacy of any long-

established dogma and who thereby disturbs the serenity and ease of less ambitious mortals is certain to arouse antagonism and excite hostile criticism rather than to invoke a eulogium upon his efforts, and should he persist in his reprehensible course of shattering cherished ideals he comes to be regarded as a meddlesome fellow and a discordant element in his professional community.

It is not to be expected that the operative steps enumerated in this book will be found expedient or convenient to follow in numerical order in every instance, but their logical sequence will, it is hoped, appeal sufficiently to operators to insure greater uniformity in the methods of procedure than has been practiced hitherto.

Greater confidence is now reposed in the operator and the present higher standard of professional intelligence demands the exhibition of greater skill at his hands.

An intimate knowledge of the surgical anatomy and relations of the temporal region is imperative to the finished operator of to-day, who must, moreover, anticipate from the external conformation and the recognizable structural peculiarities of each mastoid process upon which he operates the presence of dangerous anatomical anomalies, the existence of which a few years ago was accepted as affording ample excuse for any disastrous consequences which might supervene upon their unsuspected presence in the field of operation.

The procedure at that time was stereotyped and designed only for the successful treatment of inflammation in mastoid processes which were constructed according to rule and scale, any deviation from the fixed standard of which upon the part of the individual was regarded as absolving the surgeon of all legal, if not moral, responsibility in the premises.

The perfected technique of the modern mastoid operation,

however, admits of no such evasion of responsibility, and a patient is no longer *condemned to martyrdom because his sinus does not pursue, in the temporal bone, the course prescribed for it by Gray's Anatomy.*

The writer believes that the recent remarkable successes with the mastoid operation in our metropolitan hospitals are due in great measure to improved surgical methods other than antisepsis, and while technical perfection is in no sense the pretension of this little book, it may not, we trust, be encouraging too extravagant expectation to hope that the elaboration of the present technique may stimulate other more dextrous manipulators or keener observers to accurately record their methods and by progressive steps develop the operation to a point which shall merit the approval and endorsement of all.

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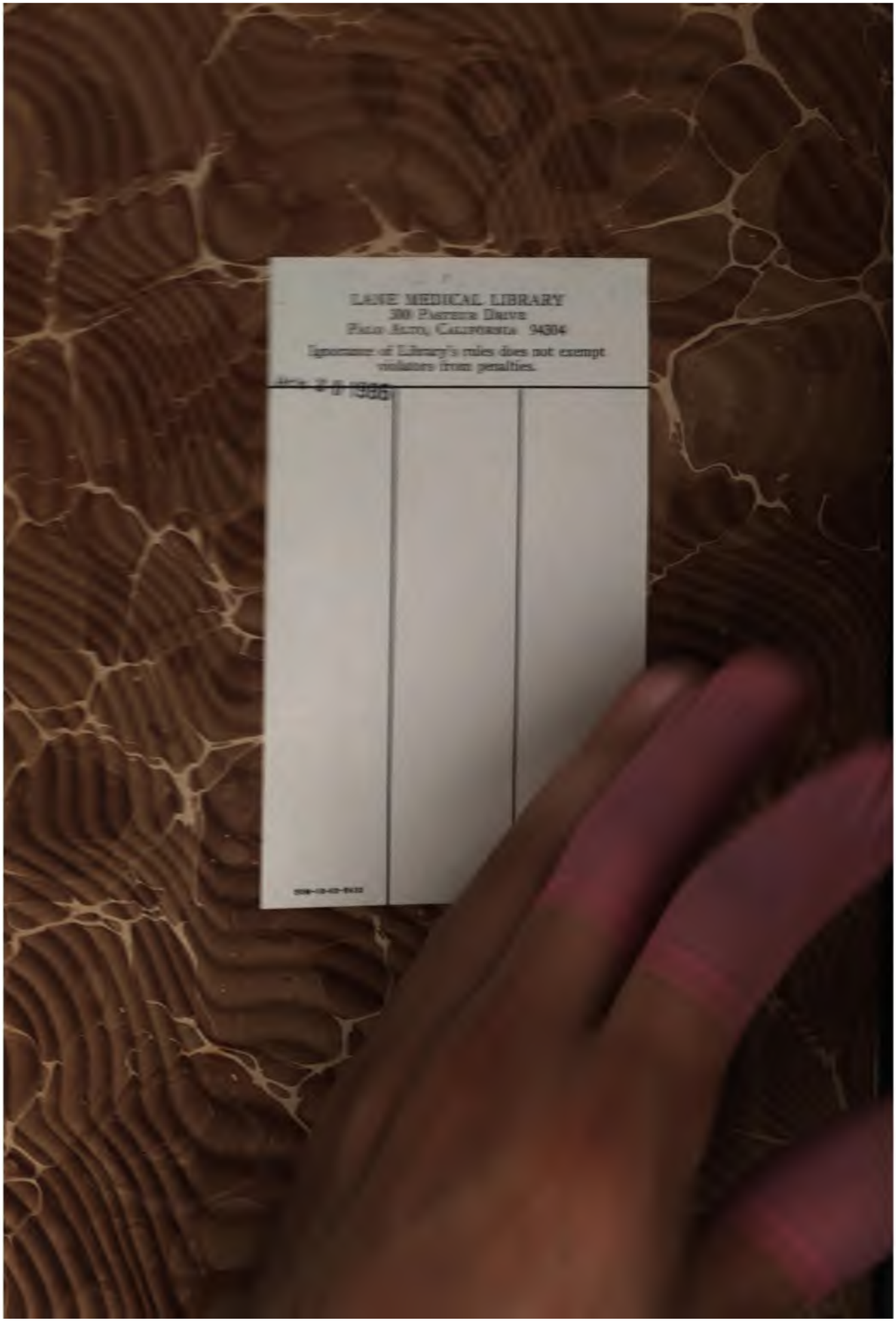
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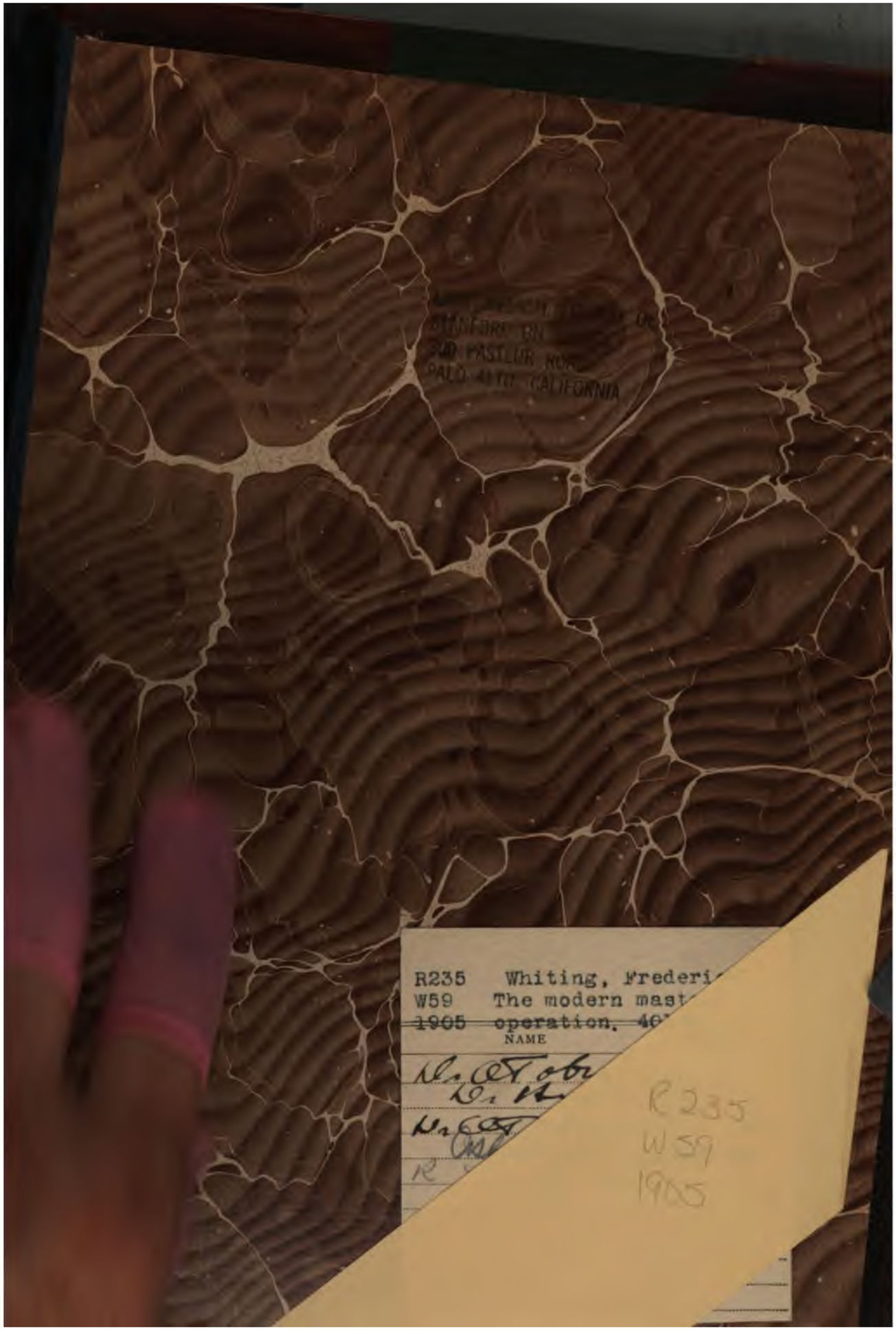
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